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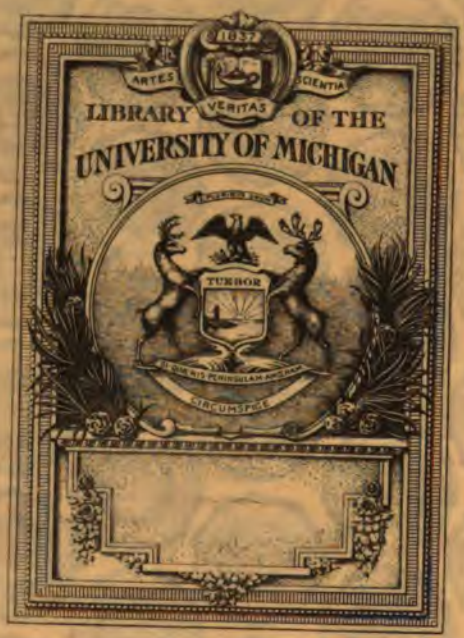
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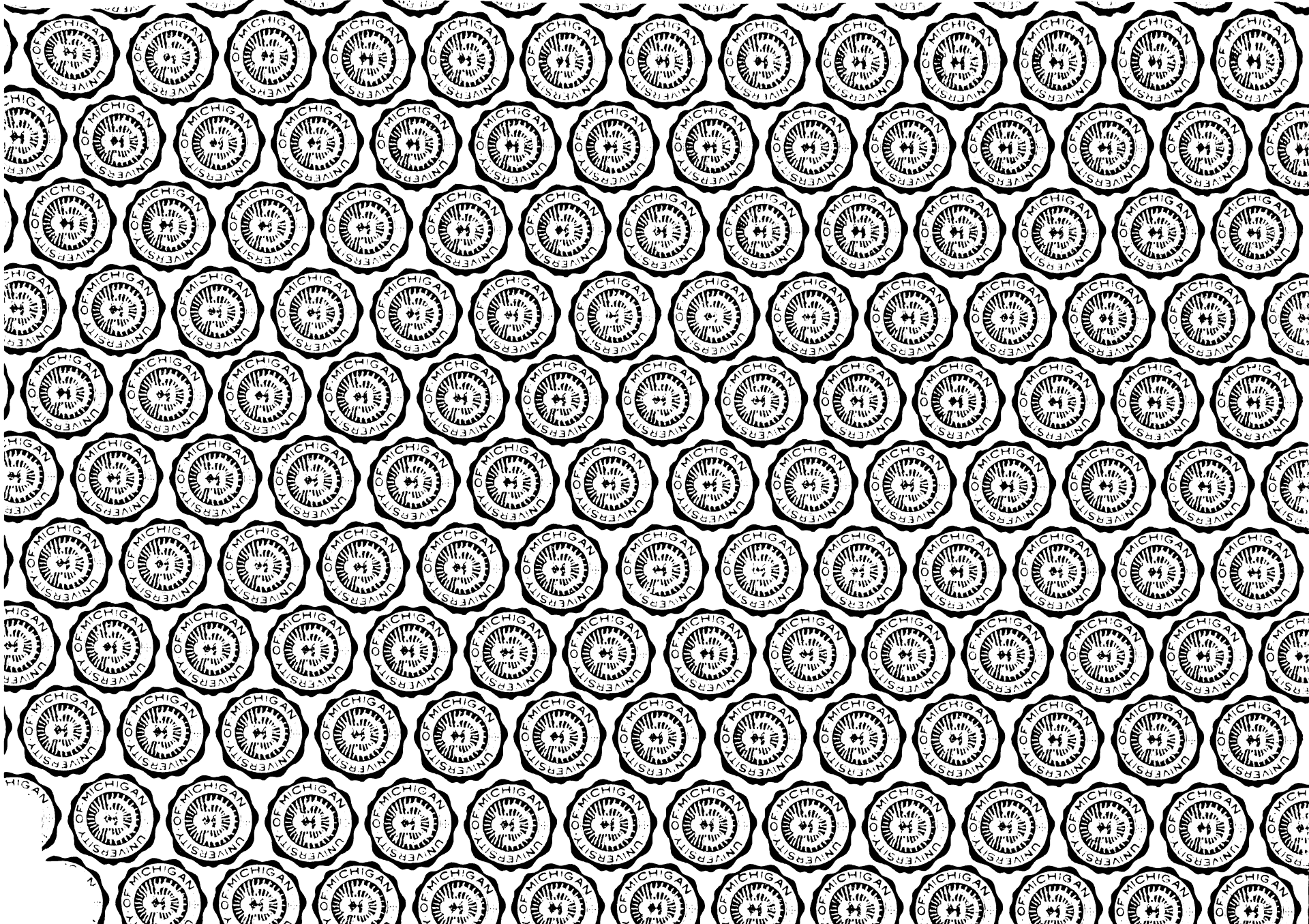
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*THE RELATION OF MODERN CHEMISTRY TO MODERN MEDICINE.**

THE history of the relation of chemistry to medicine is interesting to the physician as well as to the chemist, but has been studied mainly from the standpoint of the latter. From the remotest periods chemistry, or, more accurately, the crude science or art which preceded it, found application in two directions, first, in the treatment of metals or ores or similar bodies to produce something of greater value, and secondly, in the curing of disease or prolonging of life. In both fields of effort the attempts were and remained through some thousands of years of the simplest character. Even in the work of Galen, who flourished two hundred years after Christ and who has been styled the first of the great physicians, there is little which suggests any attempt toward a systematic knowledge of chemical substances. According to the philosophy of the Egyptians and Greeks then current, all things, including the human body, were made up of a limited number of elements or qualities, usually four. With the proper mixture of these the body remained in normal health, but with the qualities out of proportion disease followed which must be attacked through the corrective agency of medicines. Galen's medicines were mostly simple vegetable infusions or extracts of roots, barks and leaves, and the term galenical we still retain to describe the remedies which are essentially indefinite mixtures secured by processes similar in principle to those introduced by

* Address before the Sigma Xi Society of the University of Kansas, June 6, 1904.

the Egyptian. After 1,700 years of progress we still find many disciples of Galen among us, and the remedies which are 'purely vegetable,' or advertised to be, find yet among the ignorant the largest sale.

The beginnings of chemical and medical knowledge came to western Europe through the Arab conquest of Spain and in that country were nurtured through many years. Alchemy and theology, however, developed more rapidly and the learned showed greater interest in the transmutation of metals and the saving of souls than in the perfection of means for curing the ills of the body. The system of Galen remained adequate for the needs of physicians through a period of 800 years following the Moorish conquest. It could not be otherwise with miracle shrines in every village and burning fagots for all that doubted.

In the sixteenth century we recognize the first systematic attempts made to improve on the materia medica brought down from Greece and Egypt. Paracelsus began to teach the value of artificial products in the curing of disease, and, although meeting with great opposition, he with his pupils gradually built up a creed which flourished a century and a half. Paracelsus, familiar with the doctrines of the alchemists, and through extensive travels well acquainted also with the operations in metallurgy in many countries, set about to apply the gradually accumulating knowledge to the production of chemical remedies for human ailments. He promulgated a crude theory of the normal conditions of the body and, like Galen, assumed that variations from that normal could be corrected by chemical agents. Civilized as well as uncivilized man has usually been a believer in materia medica, and the notion that arsenic or mercury or antimony or sulphur could build up what disease had torn down possessed an element of plausibility that rapidly attracted adherents. Medicine became, in effect, a branch of applied chemistry and the chief energies of physicians were bent in the direction of medication rather than toward the development of diagnosis. We can not wonder at the subsequent failure of the system, since it grew into a kind of exaggerated empiricism not far removed from quackery. Indeed, it is difficult to realize at the present time how the iatro chemistry developed and flourished as long as it did. It must be remembered that chemical analysis was then quite unknown, and of chemical compounds only such were in use as could be easily made from a small number of native minerals and the simple inorganic acids and alkalies then available. Of the substances called organic very few had been discovered. A system of chemical therapeutics based on so slim a foundation failed, then, because of the wide divergence between what was confidently promised and what experience showed was practically realizable. But while no good came directly from this approach of chemistry to medicine, the indirect results were more important, since the large number of physicians turned chemists accomplished the discovery of many new substances.

We hear little more of the influence of chemistry on medicine through the one hundred years following the decline of the iatro school. Not, indeed, until the time of Lavoisier and his colleagues, when the explanation of the respiration process in its relation to oxidation and combustion and the investigations by the calorimeter on the origin of animal heat called again attention to the possibilities of chemistry in the development of medicine. About the same time came the discoveries of Galvani and Volta, the importanee of which was soon recognized. Those were inspiring times for the real science of chemistry newly born, when each day, almost, added some new fact to the rapidly filling store-house. The learned in all lands stood amazed at

the news brought in the journals or just as often in the letters from Paris, or London or even from little Weimar, where the Wahlverwandtschaften reflected the curiosity and enthusiasm of the epoch. There was for a moment danger that the medical-chemical history of the seventeenth century would repeat itself at the beginning of the nineteenth, when oxygen and the galvanic cell began to be hailed in some quarters as offering the key for all mysteries and the cure for all diseases. But the three hundred years following the rise of Paracelsus had produced a new race of thinkers, and only temporarily could men be brought away from a now well-developed and necessary tendency—the collection and investigation of facts.

It is not my purpose to sketch the fruitful work of the next half century, as I wish to speak particularly of a later period, but it must be recalled that the pioneer labors of Dumas, Liebig and Wöhler in organic chemistry made possible the later developments in physiological and pathological chemistry. In this period of great scientific activity it must be admitted, however, that the practical influence of chemistry on medicine was not very great. Each discipline developed largely in its own way, and while the practitioner recognized in physiology and physiological chemistry sciences of great interest and beauty, he was not very clear as to what uses he could make of them except in a few limited directions. Chemistry had become completely divorced from pharmacy and cared nothing for the preparation of remedies, and the applications of chemical analysis which might prove an aid in diagnosis were as yet few and far between. In the eyes of the medical practitioner and medical student chemistry was very theoretical, to be tolerated rather than to be cultivated. I have elsewhere called attention to the almost futile efforts to build up courses in chemistry in the early medical schools of the United States. The efforts failed here as, practically speaking, they failed elsewhere at the same time because of the lack of immediate relationship of the one science to the other. A medical man might just as well be asked to study botany or zoology as chemistry, as far as any really helpful practical application was concerned, excepting, perhaps, in two or three simple tests.

And so the situation remained until about 1860, when the views of Pasteur on alcoholic fermentation and the isolation by the German physiologists of several active soluble ferments or enzymes of the animal body began to attract wide attention and point the way toward an explanation of many processes taking place in the organism. With the growing recognition of the character and importance of the work of the enzymes I think we have the first real tangible evidence of the dependence of medicine on the new chemistry. The doctrine of the ferments as applied to the chemical changes taking place within the body is one, apparently, of indefinite extension, and at the present day, after forty years of trial, it seems more than ever likely to hold its own and be capable of even wider development. In passing, I must add that it would not be fair to claim that the great advances just suggested were all due to the efforts of chemists. On the contrary, many of them were conceived and largely worked out by men who had been trained primarily in medicine rather than in chemistry.

In speaking of the relations of modern medicine and chemistry it may be recognized that they are essentially of three kinds. We have first the very simple and so-called practical relation in which chemistry becomes an aid to medicine in the way of diagnosis. Here analytical chemistry is alone concerned and the chemist is called

upon to determine by tests the normal or pathological character of some body fluid or excretion about which the physician must have information before he can make a correct diagnosis. This work is, of course, extremely important, but, as ordinarily applied, it calls, perhaps, for the lowest order of chemical knowledge and represents the lowest requirement which can be made in the chemical education of the medical student. In the hands of the medical practitioner chemical analysis degenerates usually into a routine performance in which a few very simple and accurate tests are carried out in a marvelously inaccurate manner. Medicine is as yet very far from availing itself of the great aid which analysis is ready to offer in the solution of its practical problems in every-day experience, and this is largely due to the fact that in most of our medical schools instruction in chemistry stops before the student has become sufficiently familiar with the real science to feel at home in its applications. All medical students learn something about sugar and albumen and they usually are able to apply their laboratory acquisitions in later practise. But the same can not be said of their experience with acetone or indican or the aromatic sulphates, for example. These, too, certainly have a meaning, and the student has probably learned the tests for them in his laboratory work. But, unfortunately, their relations to disease are less tangible; their bearings do not become clear without a greater mental effort, and hence the once acquired facility is allowed to slip away, or to degenerate into a valueless routine, in which an assumed accuracy may be wholly illusory.

Supposing, however, that the medical man's knowledge of analytical chemistry is full enough and satisfactory for the purpose, and that he continues to practise and even improve upon the tests which he has learned, something more is still desirable or necessary. Much that should be possible in diagnosis is often lost because of the difficulty in connecting that which is shown by analysis with what it indicates or depends upon. The value of analytical chemistry in medicine soon reaches a limit unless it is accompanied by a very much fuller knowledge of general physiological chemistry than is usually acquired. And, moreover, while routine analytical work may be extremely important, in many cases really essential to diagnosis, it is far from representing the major service which chemistry may render to medicine. By analytical tests we are able to measure some of the effects of certain reactions taking place within the body, but the causes of the reactions and the relations of the things reacting involve ordinarily much deeper problems than those of simple analysis. An illustration may be given. Some years ago Ehrlich introduced a valuable test in the examination of urine which is commonly known as the diazo test, and which depends on the formation of an azo color when a certain reagent is added to the urine. To complete the reaction some aromatic product must be furnished by the secretion, and the presence of this was supposed at one time to be indicative of a definite pathological condition. Later, through more extended clinical observations, it seemed possible to connect it with still other conditions, and then a long discussion arose as to the limits and usefulness of the reaction. Among the many papers published in the discussion some have been good and some bad, even absurdly bad, because they overlooked wholly the essential conditions of the reaction considered from the chemical standpoint. It is evident that many of the writers on the subject were unfamiliar with the chemistry involved in the diazo combination and were, therefore, led to absurd expressions. To fairly comprehend a problem of this kind

a good knowledge of elementary organic chemistry is necessary, and it is essential also that one should have some idea of the part played by bacteria in the organism in producing complex aromatic substances from the disintegration of proteins, since the indications here are often of great importance.

And this brings us to consider the second type of relation between chemistry and medicine, a relation which involves the question of organic synthesis or disintegration in the animal body. At an earlier stage in the discussion it was assumed that, Topsy like, things 'just growed that way.' Later the mysterious electricity and still more mysterious vital force were called in to account for everything not easily explicable by known chemical or physical means. While it is probably true that many of the phenomena of life are and will remain quite beyond our power of explanation, and that here as elsewhere we must accept the *ignoramus* and *ignorabimus* of Du Bois Reymond as final, we are coming, on the other hand, to the recognition of the comparative simplicity of other problems, the solution of which falls within the province of the new physiological chemistry. Medicine will be the chief gainer by these investigations.

It was certainly an auspicious day for chemistry and medicine also when Pasteur developed his biological theory of alcoholic fermentation. Not long after came the work of Kühne, Brücke and others on the enzymes, already referred to, and finally Buchner to clearly demonstrate the long-suspected enzymic character of the yeast ferment. Practically all recent work in this direction has gone to show that so-called organized fermentations are all dependent in turn on enzymic ferments contained within the cells. This distinction may probably be made: in the yeast fermentations, for example, the sugar to be converted is drawn into the cell, and the products, alcohol and carbon dioxide, formed by the zymase, are in turn excreted. In diastasic and similar fermentations, on the other hand, certain cells produce an active ferment which is discharged to do its work outside the generating cell. The difference is thus seen to depend on the place where the reaction occurs, which is not a very important point. The ferments are essentially complex chemical substances, able to bring about various reactions nearly all of which are of exothermal character. Of the nature of many of these reactions we have pretty accurate knowledge, although of the exact mode of action of the enzyme itself our knowledge is scanty. For the present purpose, however, it is sufficient to recognize that these reactions are chemical and we are in a position to trace their bearing on medical problems.

The simplest problems of enzyme action we have in the work of some of the so-called digestive ferments. In the changes wrought in starch by the saliva and by one of the pancreatic ferments the chemical action is one of hydrolysis and very similar to that occurring commonly in the vegetable world. In the germinating seeds, when starch becomes sugar to feed the developing plantlet, water is added through the aid of diastasic ferments, and later, in the ripening of many fruits the same kind of a reaction takes place. These effects, however, are not peculiar to the enzymes; experiment shows that the same starchy substances acted upon by weak acids pass through the same series of changes occurring in the body, and even prolonged heating with water has the same general effect. The hydrolytic and purely chemical nature of carbohydrate digestion becomes at once apparent. What happens in the digestion of fats is equally simple. Here, too, hydrolysis plays the most important part and the work of the lipase enzymes can be

duplicated in the vegetable kingdom and also in the laboratory by the aid of the simplest of inorganic reagents. A far more difficult problem for a long time was to account in any way for the changes taking place in the digestion of proteins. The presence of a proteolytic enzyme in the gastric juice was recognized definitely by Brücke over forty years ago, and about the same time a substance called trypsin was found in the extract of the pancreas. These substances acting on proteins under certain conditions convert them into a series of intermediate and end products about which an enormous literature has been developed. In the course of the long discussion it was discovered that many of the products which are formed by the enzymes may be obtained by the action of weak acids or alkalies, or water even at an elevated temperature, on the original proteins, and finally it was shown that an increase of weight follows in these cases as in the case of the addition of water to starch. All this evidently places the phenomena of protein digestion in the group of hydrolytic reactions, along with the much simpler starch and fat reactions. The digestion processes are, therefore, chemical, and the only thing about them which remains mysterious is the fact that from one set of body cells a ferment working in acid medium is produced, while from a second set of cells a somewhat similar ferment working in an alkaline liquid is secured. Furthermore, all these changes seem to belong to the great group of catalytic reactions, of which more will be said presently.

The general character of these operations was pretty distinctly fixed years ago and their importance clearly recognized. The chemical nature of the several enzymes themselves, however, is not known; the commercial products called pepsin, diastase, etc., are merely crude mixtures of which the active substances make up but a small part. The investigation of the properties of these enzymes opened the way for the study of other reactions peculiar to the animal organism, which are likewise undoubtedly of enzymic origin. In fact, the view is gradually gaining ground that by far the largest number of the body functions involve in some way the action of enzymes. The digestion phenomena are among the simplest and most readily observed, but patient investigation has brought to light other reactions as truly enzymic as these. In the liver alone there are no less than ten well-defined processes in progress, in the initiation of which enzymes are concerned. For the maintenance of the wellbeing of the body the proper performance of these processes is as essential as is digestion itself. In a general way most of these processes have been known or suspected for years, but they were supposed to depend on some peculiar vital action of the liver cells themselves. The situation here is analogous to that regarding the mode of action of the yeast cell, but most investigators now consider the enzymic or chemical theory as well established. The liver may, indeed, be compared to a laboratory in which important syntheses and decompositions are constantly taking place. Some of these are of such a character that they may be easily duplicated *in vitro*, while others appear to be practically beyond artificial control. What is true of the liver is true of other organs where matter undergoes change. In the blood the presence of several of these ferment agents has been shown.

These various observations have had an important bearing on a discussion which has been of long duration. Since the days of Lavoisier physiologists have been trying to define the means by which the oxygen taken in by the lungs effects the oxidation of the food stuffs. Sugars and starches consumed yield finally water and carbon

dioxide. In this oxidation just as many heat units are liberated as would be set free by the same kind of combustion in a calorimeter. If work is done at the expense of the consumed food stuffs it has been found that the animal makes a somewhat greater return of mechanical energy than is possible with the best machines known. But while all this is interesting and important, it leaves the main question still unanswered: How is it accomplished? To effect such oxidations artificially would require very high initial temperatures. We can not burn sugar by the aid of the oxygen of the air except by reaching first a certain kindling temperature. To burn fats or proteins would be equally difficult. Yet in the animal body, and in the presence of fluids with a mean temperature below 40° Centigrade, the oxygen given up from the arterial blood accomplishes these combustions continuously and with a regularity corresponding with that of respiration. The theories advanced to account for this oxidation have been many and all more or less unsatisfactory. By some it was supposed that the oxygen was first thrown into an active form like ozone, for example. The old Berzelius notion of catalysis was even fifty years ago advanced as a hypothesis, but nothing definite was suggested as to the nature of the catalytic agent. It is an interesting fact that after years of fruitless theorizing chemists are coming back to the idea of catalysis, but from a very different standpoint. The peculiar catalyzing agents active in so many ways in the body are now often assumed to be some of the so-called oxidizing ferments or oxidases. The theory of the oxidases is of rather recent development and there seems to be no question of the existence of these active principles in many vegetable products. Their actual presence in the animal fluids is not so readily demonstrated, but as a result of experiments a great many investigators have been gradually brought to accept this idea as a fact. What Ludwig forty years ago pointed out as likely is actually coming to pass. Chemical physiology is becoming largely a study of catalytic reactions.

Among all the animal oxidations great interest attaches to the combustion of sugar in man. In the digestion of carbohydrates some hexose sugar is finally produced and absorbed and then carried by the portal circulation to the liver. There it is temporarily stored up as glycogen, and, as required, is thrown out into the blood stream again to be oxidized for the needs of the body. Normally this oxidation takes place very quickly and no accumulation of sugar in the blood follows. But under certain conditions the oxidation of the sugar becomes very imperfect or fails entirely, and to maintain the proper osmotic pressure in the blood the excess of sugar escapes by way of the kidneys. This is the situation in the disease known as diabetes mellitus. There are few pathological conditions on which more has been written. We can not say yet that the ultimate cause of diabetes is known, but many facts have been established by chemical investigation and quite recently the work of Cohnheim has shown, apparently beyond question, that for the normal oxidation of sugar the action of two enzymic bodies of distinctly different origin is required. One of these, as might naturally be expected in the light of earlier knowledge, is furnished by the pancreas, while the other comes from the muscles. The oxidation takes place, or may take place, in the fluid surrounding the muscular fibers. Cohnheim has shown that the cell structures as such are not concerned in this oxidation, as it may be brought about in clear filtered solutions from mixtures of finely ground muscle and pancreas. It is, therefore, a chemical process and one of the most interesting thus far studied. Not the least interesting and important fact

connected with the observation is this, that two bodies at least are concerned with the sugar in the reaction. One of these may act as a catalyzer for the other, or, taken together, both may act in the manner of the complement and intermediary body of Ehrlich, of which more will be said below. The point of importance here is that the theory of this oxidation has shifted around so as to become a strictly chemical one. As long as some specific action of the cell was called in to account for the observed phenomena the biologist rather than the chemist was interested in the solution of the problem. It now appears that the chemical factors are the main ones to be considered in the final effect. It remains, of course, true that the oxidizing ferments must be always the products of cell action, but the important idea suggests itself that they need not necessarily be produced by the same body which is later to use them. If investigators succeed in showing more specifically the nature of the two substances, it may be found possible to secure them from other animals and introduce them when needed, much as antitoxins are introduced.

Many of those present doubtless recall the beginnings of what is known as the germ theory of diseases. From his success in developing a satisfactory theory of alcoholic fermentation, which became of vast importance in the brewing and wine industries, Pasteur was led to study the causes of failure often noticed in practical fermentation. Beers and wines sometimes become diseased and spoil in the process of making. They turn sour, or for other reason become unfit for use. The explanation of this was found to lie in the presence of foreign ferments which induce new reactions. As a preventive of such diseases sterilization and pasteurization processes were suggested and have become common in many industries besides those for which first developed. From sick beers and wines Pasteur was led to study sick silkworms, then a question of great commercial interest in France, and found the cause of the malady and later a method of prevention. Following this wonderful work, men began to look for microorganisms elsewhere, and in the course of a few years specific bacteria were described as the active agents in inducing cholera, anthrax, tuberculosis and other dread diseases. According to the germ theory, the invasion of certain tissues of man or the higher animals by these bacteria is the real cause of the disease in question. It must be recalled that these organisms are extremely minute. Many millions of them would be required to produce the volume of a pin head, and that anything so small could give rise to cholera or typhoid fever seemed at first utterly unreasonable. That these minute things are the actual agents of many diseases there can now be no doubt. It remains to discover how they act. At first their effects were assumed to be largely mechanical and in the direction of the destruction of tissues, but in many cases the tissue destruction is of secondary importance. The notion gradually developed that many of the disease-producing bacteria are active through the poisonous principles or toxins which they elaborate. The toxins are complex chemical substances resembling in properties some of the alkaloids, or possibly belonging to the group of enzymes. At any rate, as soluble chemical agents, they are able to diffuse throughout the body and interfere with its normal functions. We appear to have then a chemical theory back of the germ theory and this development is proving of the highest importance from both theoretical and practical standpoints. The theory of the production of toxic substances by the bacteria involved, of course, no new assumption. Chemists had been long fa-

miliar with the production of poisonous matters by other vegetable cells, and the development of ptomaines, or cadaver poisons, was sufficiently well understood to suggest at once the formation of analogous substances in the living organism. Hence the doctrine of the toxins as the important chemical factors in the causation of certain diseases, when once clearly stated, made rapid headway and is now very generally admitted and recognized. The investigation of bacterial intoxications has become a chemical problem of rare fascination and importance, and through this work entirely new departments of research have been opened up, bringing into the practise of medicine, as well as into the literature, new ideas and new methods. The development of the notion of toxins was followed by that of the antitoxins, the potent agents which check or prevent the harmful work of the toxic ferments. The theory of the action of these substances on each other is largely a chemical one and is founded on a basis of experiment. It appears that in many cases studied toxin and antitoxin combine in fairly definite and constant proportions, which would necessarily be the case if their union is in any sense a chemical one. The behavior of one with the other has been compared to that of an acid with a base, but it is more like the combination of active salts to form complex double salts of entirely distinct properties. The extreme toxicity of potassium cyanide, for example, is modified by combination with iron compounds to produce the salt of a new and far less potent acid.

Few topics in medicine to-day attract the attention given to natural and acquired immunity. The history of scientific investigation in this field is not old, but already its literature has become enormous. Immunity may exist with reference to bacteria, or to the toxins produced by bacteria, and in either case it may be inherent or natural or it may be imparted. The natural immunity of many animals to bacterial invasion does not necessarily involve any direct chemical action, and in the most widely accepted notion yet advanced to account for this kind of immunity certain large cells of the body, which have been called phagocytes, or devouring cells, play an important part. These seem to seize upon the foreign invader and destroy it by a kind of digestive process. Such a property is observed in the large white corpuscles or leucocytes of the blood, and it is likely that a chemical action is indirectly concerned here. The cells may produce some specific chemical substance which is a poison for the attacking bacteria. It has also been held that in the gradual and spontaneous disintegration of these cells substances are thrown into the serum which have the real germicidal action. These are the alexins of Buchner, and in the theory of the latter they are enzyme-like substances. What the exact facts are we do not know, but I refer to the point to emphasize the growing tendency to look for the chemical factor in every body phenomenon.

In the study of acquired or developed immunity to bacterial toxins we find the most ambitious introduction of purely chemical theories. In this field the labors of Pfeiffer, Buchner, Bordet, Ehrlich and others are preeminent, and in all cases the chemical idea appears as an essential factor. This is peculiarly true of the so-called 'side chain theory' of Ehrlich, which at the present time attracts the widest attention. Years ago Pasteur introduced the notion of molecular asymmetry into chemical science and pointed out in effect the importance of the conception of configuration in dealing with certain problems. In 1894 during the progress of his famous investigations on the bodies of the sugar group, Emil Fischer published some remarkable

papers on the behavior of certain enzymes in the fermentation of sugars, in which he pointed out that in order to work as ferments the enzymes must possess a certain stereo-chemical structure, bearing a definite relation to the stereo-chemical structure of the sugar. Without this relation fermentation can not take place. In order to make his meaning plain Fischer employed a figure which has since become famous. He said, in speaking of certain glucosides: 'Enzyme and glucoside must fit into each other as a key into a lock in order that the one may be able to exert a chemical action on the other.' In one of these papers Fischer suggests that the idea of related molecular configuration of enzyme and fermentable body may prove of value in physiological investigation as well as in chemistry. We have apparently in this prediction of Fischer made ten years ago the basis of the Ehrlich hypothesis.

Without going into minute details, the Ehrlich notion of bacterial or toxin action on the cells of the body, and immunity from the same, is briefly this. Bacteria, animal cells and toxins are all complex aggregations of more or less complex molecules. The latter have certain configurations dependent on the presence of side chains or side groups, to borrow an expression from organic chemistry. These side chains are directly or indirectly the points of attack or defense in the action of the several bodies on each other. In order that a substance may behave as a poison or toxin to cells of the body, both cells and toxins must, therefore, possess certain reciprocal configurations. It has been suggested by Ehrlich that it is through the presence of these side groups that the cells absorb their necessary nutriment and elaborate new structures from it. Some of the side chains may be constructed to combine with fats, some with carbohydrates and some with proteins, but in the presence of toxins or bacteria with the right kind of side chains combination with these may take place instead. Certain phenomena seem to indicate that this combination is not a direct one, at any rate not always direct, and the conception of an intermediary body or linking complex has been developed. This intermediary body must itself possess two groups with special configurations; one of them fits it to combine with the cell, while the other brings about the combination with the toxic molecule.

The complicated nomenclature called into existence to describe and express satisfactorily the conceptions of this interesting theory appears at first sight a great drawback in the way of readily following it. There are cytophil groups and toxophil groups, and both of these may be called haptophorous groups because they carry the combining or uniting property. Other terms employed sound equally strange to the chemist, but a little patient study discloses what is meant and we are obliged to recognize in the new doctrine an important widening out of biochemical science. Of course no one assumes that the theory, or the various other theories which have grown up around it, will persist in the present form. The chemistry of living things is admittedly the most complex of all kinds of chemistry. For new ideas we must have new figures and these of Ehrlich in the side chain theory are not more unreal than were the figures employed in the early days when a general chemistry began to be evolved from the atomic theory of Dalton. Besides this, the stereo-chemical speculations of Ehrlich and his school present for the first time a tangible working hypothesis to account for the phenomena of toxicity and immunity. In many respects the hypothesis or theory will suffer modification and so discard what is useless or false. But already it has stimulated investigation enormously and created in

medicine a situation analogous to that created in chemistry by Pasteur and van't Hoff and developed largely by the latter and Fischer. In this new medical chemistry there is the same distrust to overcome which was encountered by van't Hoff in the first years after the publication of his work on chemistry in space. It may be recalled that Kolbe especially was very bitter against what he called idle speculation and this is the attitude to-day toward an attempt to explain obscure phenomena in etiology in chemical language. It is true that complete chemical explanations of pathological conditions are in most cases not yet possible, but the bold speculations of Ehrlich, Buchner, Bordet and the other scientists who have contributed to the discussion deserve cordial recognition. It is no fatal objection to their hypotheses that the leaders in the various schools differ as to details. The fact of permanent value is that they are all at work on a theory which is essentially chemical.

The organic chemistry of the protein substances has advanced far enough to show that these bodies are complex aggregations of certain large and small groups. The elimination or destruction of some of these groups may not necessarily mean destruction of the whole molecule. Doubtless it may remain a protein with several of the smaller groups lost. Outside of the animal or vegetable organism there is apparently no simple way of regenerating what has been obliterated. In the living tissues, however, the proteins may possess the power of self-regeneration by some kind of a synthesis; the loss of a few amino groups, for example, need not be followed by the decay of the whole. These amino groups may be convenient points of attack for certain reagents, but not for others. They are, in a sense, the toxophil groups by means of which outside connection is made, but if the proper attacking agent is not used the protein remains unchanged. It is also true that certain reagents may increase the stability of the protein and inhibit practically its destruction under given conditions. In general such molecules possess greater stability in presence of their dissociation or reaction products. Conceptions somewhat analogous to these are included in the Ehrlich immunity theory, according to which some of the separated side chains from the over-stimulated cell behave as antitoxins to check further action.

In still another important direction the influence of chemistry is being felt in medicine and it is the new physical chemistry which is now the vitalizing force. In one of his earlier papers van't Hoff called attention to what this kind of chemistry might do for physiology, and in recent addresses he has come back again to the subject. Ostwald has many times, and even more strongly, pointed out the importance of physical chemistry to the progress of medical theory. As long as physiology alone was concerned in this advance the influence on practical medicine remained somewhat problematical. The clinician has been almost as skeptical about the value of pure physiology as he has been about the value of pure chemistry. But many of the newer developments from the theory of solutions have been found applicable in questions of pathology, the recognition of which fact is of growing importance. A few of these so-called practical applications may be mentioned here.

It is a well known yet always interesting fact that the osmotic pressure of the blood remains within narrow limits a constant. A slight increase following meals or a decrease following large consumption of water is speedily corrected through the activity of the kidneys. The importance of this constancy in osmotic pressure appears when it is recalled that all the other organs of the

body are more or less surrounded by the blood and necessarily in equilibrium with it. Any great variation in the osmotic pressure of the blood would, therefore, be followed by a change in the content or concentration of every dependent cell. It appears to be a special function of the kidney, therefore, to eliminate just enough of the accumulated blood products to keep this mean osmotic pressure at its normal value. If in any given case a wide divergence from this is found by experiment, the conclusion is at once drawn that some serious impairment of the kidney has taken place. The test is easily made with a small amount of the blood by what is known as the cryoscopic method. Its diagnostic value is generally recognized.

Similarly, we have in the determination of electrical conductivity another simple method of finding a certain kind of solution content. This method may be applied to body fluids, especially to the urine and to the blood, and the information secured has often considerable value, since it is not exactly the same as may be obtained by the methods of chemical analysis. The general procedure has been applied in other kinds of work, twenty years or more, but only within the last four or five years have the applications in medicine been thought of. It will be recognized that these applications are comparable to new methods of analysis and their value must be measured from that standpoint.

But the chief value of physical chemistry to medicine does not lie in this direction, practical as it may appear. The development of the modern theory of solutions has wrought a most wonderful change in our mode of thinking of chemical problems, and while for a time this change was noticeable mainly in the treatment of questions of inorganic chemistry, it has finally appeared in the discussion of medical problems also. In pharmacology the conception of independent ions is a helpful one in explaining many points in the action of drugs which have hitherto been obscure. It is well known that the chemical activity of many substances in solution may be greatly modified by the presence of other substances having like ions free. Physiological activity, it is found, is often modified in the same manner, and beyond question the problem here presented will be found a fruitful one in the theory of medication and in the explanation of incompatibles. The importance of certain ions in the blood and in the muscular juices has just begun to be clearly recognized and the maintenance of these in right amount, even when only traces may be present, is a chemical necessity. It is known that the inorganic substances which yield ions have a necessary duty to perform in the body. The constancy of the one per cent. of mineral substances in the blood is doubtless more necessary than the constancy of the twenty per cent., or more, of organic substances.

The physical chemists have given us a number of new general methods of attacking old problems. Some of them have an important bearing on live questions in medicine. For example, take the question of the solubility of uric acid and the urates, the deposition of which in the tissues is supposed to be the source of many disorders. For fifty years or more much has been written on the problem of dissolving these urate deposits or concretions, or of preventing their formation. Lately several writers have begun to study this ever-interesting topic from the standpoint of the mass action law and dissociation hypothesis, and in a way which promises much for the clearing up of the fundamental conditions of deposition. It has already been pretty well shown why certain suggested remedies have not been of value and can not possibly do what was long claimed for them. In the uric acid problem two fundamental ques-

tions are involved; one of these has to do with its formation in metabolism. The other is a question of chemical equilibrium at a given temperature. The first question is the more difficult and also practically the less important. The second question may not prove difficult of solution.

I have spoken of the great work of Ehrlich and others in the development of the doctrines of immunity and toxicity. In the experimental examination of this problem it was found that many reactions between toxins and antitoxins can be carried out in the test-tube, leaving for the animal experiment certain final or crucial reactions only. In other words, a large number of important points in question seem to be strictly chemical and must be tested by chemical rather than by biological methods. In deciding on the nature of any given reaction taking place in solution and requiring time for its completion a determination of the so-called speed of the reaction is often of value. It has been shown that reactions taking place in one direction and involving one, two or three molecules follow certain definite schemes. The behavior of some of the simple ferments has been studied from this point of view and lately it has been found possible to submit the reaction between toxins and antitoxins to this kind of mathematical analysis. Something over a year ago Arrhenius and Madsen published a very important paper with the title: 'Applications of Physical Chemistry to the Study of the Toxins and Antitoxins,' in which, from the observations of Ehrlich, the essentially chemical nature of these reactions was shown. This paper was followed by others by the same authors and also by Ehrlich, who takes exception to some of the physico-chemical generalizations, yet recognizes the value of the mathematical treatment. It is likely that this discussion is but the beginning of the application of physical and mathematical chemistry in the exact study of problems which at one time were assumed to be essentially biological. I believe that medical science will derive great benefit from this alliance, as a means is here offered of testing the value of many assumed working hypotheses. There is a field here which is worthy of attention and which certainly can not remain long unoccupied. Many reactions taking place normally in the body will be found to lend themselves readily to the physico-chemical treatment and the applications in pathology will also appear as the methods become better understood.

Many medical men are beginning to recognize the value of this line of inquiry in the development of research, and the question is often asked how may the practitioner of medicine make himself familiar enough with the new physico-chemical theory to derive any benefit from it. This is admittedly a difficult question. With the student of medicine, however, the case is different. He may be given from the start the proper training to enable him to understand something of the drift of this new chemistry, if not to practise it readily. An opinion has been cultivated for years in some of our medical schools that the only part of chemistry really important for the physician is the organic chemistry of the food stuffs and their metabolic products. This is an extremely narrow conception of the case and it has often led to a neglect of those branches of general and physical chemistry through which the foundation principles of the science may be most satisfactorily presented. With the growing importance of the applications of physical chemistry in medicine the chemical training of the medical man will have to be correspondingly advanced, and of necessity the foundation work in this training will have to be done in the freshman and sophomore years of our scientific

schools and colleges, since few medical schools will have the equipment or be able to afford the time to do it properly. Physiological chemistry will become then a first-year study in all of our medical courses, and the young man beginning the study of medicine must bring with him a knowledge of general inorganic and organic chemistry sufficiently broad to enable him to grasp the new problems which medicine now presents.

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SCIENTIFIC BOOKS.

Handbuch der Fischkrankheiten. Von Dr. Bruno Hofer, Professor der Zoologie an der tierärztlichen Hochschule und Vorstand der Kgl. Bayer. Biol. Versuchsstation für Fischerei in München. Mit 18 Farbentafeln und 222 Text-Abbildungen. Verlag der Allg. Fischerei-Zeitung, München. 1904.

This is the first book devoted exclusively to the diseases of fishes, a volume of 359 pages well printed and well illustrated. The author asserts that the first aim of his work has been to aid the practical fish culturist and secondarily to gather together the substance of the few widely scattered scientific papers on the subject and his own unpublished material, the result of his observations as director of an experiment station. No technical knowledge is necessary to make use of the book. Particular diseases are described under the heads of external symptoms, course, cause, cure and prevention, the pathological changes receiving but passing notice. The scope of the work is limited to middle Europe and to fresh-water fishes alone, with Siebold's 'Die Süsswasserfische von Mitteleuropa' as a basis of nomenclature.

The book is divided into four sections. These treat of general infections, diseases of special organs, the crayfish disease, and general measures against fish diseases. Fourteen bacterial diseases are described, of which six are regarded as specific infections, and the characters of the organism are summarized. The disease itself is given a distinctive name, as 'furunculosis,' 'purpura cyprinorum,' 'pestis salmonis,' etc. The last is the widely known so-called fungous disease of salmon which engaged the interest of Huxley, who believed it to be caused by *Saprolegnia* alone. Dr. Hofer accepts the work of Patterson, who holds the fungus to be a secondary or terminal attack and describes '*Bacillus salmonis pestis*' as the primary cause. It is further interesting to note that the bacillus of tuberculosis is found in fishes, a form recognizably different from the parasite in man and not pathogenic for warm-blooded animals. Seven other organisms are found associated with disease, but their rôle is not regarded by the author as satisfactorily determined. Infections of fishes with bacteria and animal parasites are not unknown in this country, but serious epidemics due to them have been described only among domesticated fishes, while in Europe they seem to be more common and devastate alike the natural habitats as well as the ponds of breeders.

Two general infections with protozoan parasites are described, each caused by a myxosporidian of the genus *Myxobolus*. A systematic list is given, profusely illustrated and with a short characterization of each species, of the sporozoa parasitic for fishes, in which Gurley's U. S. Fish Commission paper is largely drawn upon. This plan of illustrated synopses of the species is carried out with each group of parasites, more extensively with the crustacea.

The second section occupies two thirds of the book and is taken up with local diseases. The skin affections receive most attention and its lesions are mainly caused by parasites, the most important being the saprolegnious fungi, the great enemy of domesticated fishes. None of the tissues or organs is without its pathologic affection. Even the nervous system is the seat of parasitism, the author himself having investigated a yet unnamed sporozoan which causes in trout 'taumelkrankheit,' a torpor finally ending in death. Other authors have described 'polyneuritis parasitica' due to a *Myxobolus*, and a parasitic worm. A short chapter is given to an unexplained exophthalmia, a symptom frequently seen as a

manifestation of, perhaps, several different causes, one of which is of considerable importance in this country and has been shown to consist in unusual amounts of dissolved air.

The third section is devoted entirely to the crayfish disease, 'Krebspest,' for years past widespread and destructive in Europe, but here unknown. The author and his assistant have made a special research on this subject and have described as the cause of the disease *Bacterium pestis astaci*, which attacks also, causing a general infection, several cyprinoids and allied fishes in the waters of nature as well as in domestication.

The last section consists of a few pages of general directions to the fish culturist with respect to measures to be taken at the onset of disease. In general there is little encouragement to the breeder in the way of remedies. Therapeutics with fishes is not far advanced and the prognosis in the case of the general infections is bad. Some cases of external parasitism may be successfully treated, but the chief reliance must be in prevention. Practical directions are given for the disinfection of ponds and the natural remedy is frequently advised of removing infected trout to rapidly flowing streams.

The book is profusely illustrated with colored plates, drawings and photographs, and to these it owes a large part of its usefulness. The representation in color of the lesions of the bacterial diseases aids their identification, which is rather difficult at best.

M. C. MARSH.

Katalog der Bibliothek der Gesellschaft für Erdkunde zu Berlin. Versuch einer systematik der geographischen Literatur. Von PAUL DINSE. Berlin, Ernst Siegfried Mittler und Sohn. 1903. Pp. xxvii + 925. Price, 12 Marks.

When the Berlin Gesellschaft für Erdkunde moved into its own building the opportunity was given for a rearrangement of its library. The scheme in use had become antiquated and inadequate. To Dr. Dinse was entrusted the preparation of a new plan of arrangement. The results of this work lie before us in this large and in every way satisfactory catalogue, which from its fullness and fine subject classification has high bibliographic value. The scheme of classification is close and thoroughgoing, yet based largely upon considerations of practical convenience. Two main divisions are adopted: general geographic literature and literature of single regions and the sea. Under the former are the subdivisions: (1) bibliography, (2) history of geography and discovery, (3) history of cartography, (4) methods and education, (5) encyclopedic literature of geography, (6) collections and miscellaneous writings relating to geography, (7) general physical geography, (8) general bio-geography, (9) general anthropo-geography, (10) geography of political and economic history of nations, (11) onomatology and transcription. These are again subdivided and when necessary or desirable re-subdivided, sometimes according to subjects and sometimes by countries. The second main division, literature of single regions, is subdivided by continents and countries, and when the literature pertaining to a country is very extensive, this is again subdivided by subjects. Periodicals are arranged separately by countries.

Among the admirable features the following may be noted. The names of authors, when known, and the titles of books, separates and periodicals are given without abbreviations. When doubt might arise as to where a paper should be placed, it is given in full in the two or more places where it might go. At the end of every entry is given, inconspicuously, the letter and number indication showing the exact location of the work in the library of the Gesellschaft. Under each subdivision the works are arranged in order of publication. An author index with abbreviated title and page reference enhances greatly the usefulness of the work which will prove almost as useful to geographic workers in general as to the members of the Berlin Gesellschaft für Erdkunde.

J. M. NICKLES.

SOCIETIES AND ACADEMIES.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE 151st regular meeting of the Chemical Society of Washington was held on Thursday

evening, May 12, 1904, in the assembly hall of the Cosmos Club.

The first paper on the program, entitled 'Heat of Dissociation Proportional to Atomic Weight,' was presented by Dr. E. A. Hill. The paper was a synopsis of the author's dissertation presented to the Columbian University for the degree of doctor of philosophy.

The second paper on the program, entitled 'The Colloid Theory of Plasticity,' was presented by Allerton S. Cushman. The speaker reviewed briefly the evidence which has already been published by himself and other investigators, which tends to show that the two important useful qualities of clays, viz., plasticity and binding power, are caused by the presence of a certain proportion of colloid particles. To prove this, a large amount of evidence has been collected and artificial clay bodies have actually been synthetically prepared in the laboratory, possessing all the peculiar properties of natural clays.

Experiments were made on the lecture table which showed that the addition of certain reagents, such as tannic acid, alum and ammonia, to a pure kaolin clay profoundly modifies the properties and the relation of the clay body to water. Such reagents have no action on inert crystalline particles, but they do upon colloids, producing various effects, such as coagulations, flocculations and deflocculations. Curiously enough, all these reagents, as was shown by a simple experiment, increase the binding power of clay, either by deflocculation of the colloids already present or by producing reactions involving the formation of new colloids. Acheson has recently claimed and obtained a patent for increasing the binding power of clay by treatment with tannic acid. This process is called the Egyptianizing of clay on the, perhaps, somewhat fanciful theory that it was the tannic acids of the straw infusion rather than the fiber of the straw itself which gave strength to the low binding clays of ancient Egypt. From more recent work it is questionable whether small amounts of ammonia will not produce the desired effect even better than tannic acid at a much less expense, and in so simple a manner that its use can not be restricted by patents.

For the last fifty years occasional investigators have been noticing that clays and soils have the power of absorbing certain ingredients from solutions in which they are soaked, and further, that these absorptions are selective, certain substances being eagerly taken up and others rejected. If the clay is first heated to a certain point it no longer exhibits this power, showing that it is not due to adsorption on the particles. This again is a colloid property, and inorganic colloid precipitates made in the laboratory show the same peculiarity. Clays that have been treated with tannic acid and ammonia will absorb less water than the untreated clays and will, therefore, require less water to bring them to a desired consistency. Thus the danger of shrinkage and cracking on drying out is lessened. Attention was called to the importance of the study of these selective absorptions by clay bodies in the investigations of soil physics.

The third paper on the program was entitled 'Notes on the Methods of Detection of Sesame Oil,' and was presented by L. M. Tolman. A number of imported olive oils were found by the author that gave a marked reaction with the Baudouin or Villerecchia reagents.

The substance in these oils giving this reaction can be removed by alcohol so that the purified oil gives no color with these reagents. If Sesame oil is present the reaction is not decreased by this method of purification.

The fourth paper on the program, by Peter Fireman and E. G. Portner, on 'Some Observations on the Dissociation of Chlorides by Means of a Qualitative Test,' was presented by Dr. Fireman.

The last paper on the program for the evening was a 'Note on a Bibliography of Solubilities,' presented by A. Seidell. The author mentioned that the preparation of a bibliography of solutions had been begun about eighteen years ago by a committee appointed by the British Association for the Advancement of Science. This committee reported eight years later (1894) that they had collected all the references to work on solutions published prior to 1874 in the periodicals cata-

logued by the Royal Society. This collection has never been published, the manuscript being still in possession of Professor W. W. J. Nicol, the secretary of the committee. For this reason the author undertook the preparation of a bibliography of solubilities only for the years 1875 to 1903, inclusive, and for its compilation carefully examined the tables of contents or indices of twenty-six chemical journals and in addition gives references to papers contained in a great many other journals. Short abstracts enumerating the chemical substances employed in the work are given for each reference and at the end an indexed list of all chemical compounds which have been employed in solubility investigations is given.

At the conclusion of the formal program for the evening Dr. Wm. H. Seaman, of the Patent Office, exhibited and explained a new form of spirometer (small gasometer) which may be used for testing the lung capacity, analyzing air, measuring gases, etc.

A Correction.—At the request of Dr. Chas. Baskerville the following correction in the report of his lecture contained in the May 13 issue of SCIENCE, page 758, is made. He did not call 'especial attention to the observation that all minerals which have the property of becoming phosphorescent under the action of radium rays contain the element helium,' *but* that 'those minerals which are known to contain helium and are radio-active give off a gas or emanation when heated, which may be condensed by liquid air and exhibits the same properties of causing Sidal's blende to phosphoresce as do the emanations of radium compounds and thorium dioxide.'

A. SEIDELL,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 587th regular meeting was held on May 21, 1904, Vice-president Day in the chair.

A memorial address on the late Major J. W. Powell was read by Dr. W. H. Dall. A sketch of his life was given and some of his achievements; he was said to be far-seeing, much in advance of his time, as on Indian questions and irrigation; his predominant characteristics were courage, sympathy and insight.

Professor E. A. Pace, of the Catholic University, then spoke by invitation on 'The Rhythm in Visual Perception.' In the attempt to distinguish between physiological and (possible) physical phenomena the study of threshold phenomena may throw much light. So the fluctuations in the perception of a constant, just visible light have been studied. Various writers have attributed them to the afferent nerve, to the central organ, and to fatigue of the ciliary muscle. The speaker had disproved this last view in 1891 by the use of atropine. Later observers found the periodicity stands in close relation to vaso-motor activity and respiration. The speaker's recent observations, still incomplete, on after-images show that the fluctuations are due to retinal fatigue. The paper was discussed by the audience with reference to its bearings on observations on variable stars, and on the velocity of light by the Fizeau-Cornu method.

Mr. J. F. Hayford, of the Coast and Geodetic Survey, reported on 'A Test of the Transit Micrometer, as a Means of Eliminating Personal Equation.' In this instrument the observer attempts to keep the wire on the star, and the instants when the wire passes certain fixed positions are electrically recorded on the chronograph sheet. The practical result is that in difference-of-longitude work three nights' observations by the new method without change of observers are equal to ten nights with exchange by the old key method.

After some discussion the society adjourned till October 15.

CHARLES K. WEAD,
Secretary.

THE NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

THE regular meeting of the section was held on May 2 at the American Museum of Natural History. The program consisted of four papers, abstracts of which are as follows:

The Theory of a Double Suspension Pendulum: R. S. WOODWARD.

Professor Woodward described a double suspension pendulum apparatus for determining the acceleration of gravity and gave a brief outline of the theory of the apparatus. The latter consists of two rectangular bars of brass about twenty kilograms mass each, connected by two steel tapes of equal length in such a way that when one bar is held rigidly horizontal the other bar will be suspended horizontally by the equal and parallel tapes. It was shown that when the suspended bar vibrates longitudinally through small amplitudes its motion is very nearly the same as that of a simple pendulum whose length is equal to that of the tapes. It was shown also how small corrections due to the mass of the tapes and to their rigidity may be applied in order to get from the actual apparatus results in conformity with those of a simple pendulum.

Measurements of the Primary Feathers of Recently Killed Hawks, and their Bearings upon the Problem of Bird Flight: C. C. Trowbridge.

During the spring the author succeeded in obtaining a series of measurements of the primary feathers of the hawk's wings, immediately after the death of the birds, and secured additional proof of his theory that certain birds of prey habitually interlock their primary feathers in flight.

It was found that when hawks are examined immediately after they have been killed there usually appear deep depressions in the edge of the posterior webs of the emarginate primary feathers, where the feathers have been in contact, which are caused by the interlocking of the primaries.

The measurements consisted in determining the width of these depressions at short intervals of time immediately after the death of the hawks. It was found that the depressions gradually disappeared, both in cases where the feathers were found locked and were then unlocked, and in cases where the feathers were found unlocked. Data were thus obtained from which well-defined curves were constructed, showing the recovery of the web of the feathers after the pressure caused by the interlocking feathers was relieved. A number of life-size photographs were taken of the primary feathers immediately after the hawks were killed and the photographs of the depressions in the feathers when measured by a Repsold measuring machine, gave curves which agreed very well with those obtained by direct measurement. Similar curves were obtained by artificially interlocking the primaries for several hours and then measuring the recovery of the web of the feathers with a micrometer microscope. It was found that artificial locking of the feathers for ten minutes produced very slight or no depressions and locking them for several hours produced depressions only about one half as deep as those found when the hawks were killed. In the latter case they were from 2 to 3.5 millimeters deep, and required from one to five hours to be reduced to twenty per cent. of the original depth, the rate of change of the depth of depression being most rapid at first.

It was concluded from the measurements and photographs that the primary feathers found with the depressions in the web had been interlocked several hours or more previous to the death of the hawks, which were killed while sailing in a strong wind, and that the theory of interlocking of the primaries of the wing in flight had been conclusively confirmed.

The Generation of Electrical Charges by Radium: George B. Pegram.

Dr. Pegram's paper related to the generation of electrical charges by radium, with special reference to the suggestion of Soddy that when the α particles, carrying their positive charge, are expelled from the radium, there is no corresponding negative charge left behind in the mass. A few milligrams of radium bromide were enclosed in a thick lead capsule, which was supported on a quartz rod in an exhausted vessel. Gold leaves attached to this capsule gave no indication of a charge, showing either that there was the usual generation of equal amounts of positive and negative electricity when the α particles are thrown off, if, as has been supposed, the number of α particles is much greater than the number of negatively charged particles, or else that the number of β particles is about equal to the number of α particles. It remains to try a similar experi-

ment with radium bromide which has been recently in solution, and, therefore, sends off few of the β particles.

Bending Moments in Rails, for the Same Superstructure, under Different Types of Locomotives: P. H. DUDLEY.

In previous communications to the academy, the author presented from stremmatograph tests, tabulations of the recorded unit fiber stresses in the base of rails, and their distribution under moving locomotives and cars.

The determination from the unit fiber strains, of the negative and positive bending moments of the rails, due to the passing wheel effects, indicates that for a definite construction of the superstructure of the permanent way, they are independent, partially, of the total load of the locomotive or car, but dependent upon the type of each, in construction of wheel base and wheel spacing, in loading the foundation.

In a series of stremmatograph tests, on the New York Central and Hudson River Railroad, near mile post No. 10, December 23 and 30, 1899, locomotive No. 870, an eight-wheel type of engine, weight 220,000 pounds, drawing the 'Empire State Express' of four cars, weight 430,000 pounds, at speeds of 42 and 44 miles per hour, the average positive bending moments for the engine were 12.40 inch-pounds, per pound of static load, for one rail, constrained by a negative bending moment of 1.88 inch-pounds.

The average positive bending moments for the entire locomotive were 11.48 inch-pounds, per pound of static load, constrained by a negative bending moment of 1.71 inch-pounds.

On December 30 locomotive No. 2032, a ten-wheel type of engine, with closer wheel spacing, weighing 283,900 pounds, drawing the 'Southwestern Limited' of ten cars weighing 910,000 pounds, at a speed of 40 miles per hour, at the same place as the preceding tests, the positive bending moment for the engine was 10.80 inch-pounds per pound of static load, for one rail, constrained by a negative bending moment of 2.18 inch-pounds—a more favorable result than for the eight-wheel type.

For the entire locomotive, the positive bending moment—for normal tender wheels—was 9.82 inch-pounds, for one rail, constrained by a negative bending moment of 1.90 inch-pounds, indicating a more favorable loading of the foundation. The bending moments of different types of locomotives on the same superstructure are a measure of the relative efficiency of the distribution of their loads to the foundation; while with the same type of engine the relative efficiency of the construction of the superstructure of the permanent way can be measured. These are first bending moments measured in rails under moving locomotives and cars.

Dr. H. G. Pifford exhibited an electrometer specially designed for use in measuring radioactivity and showed the action of the instrument by lantern projection.

C. C. TROWBRIDGE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

APPENDICITIS AND THE RACE.

IN the possible effects upon the race of surgical intervention as a cure for disease we have a curious anomaly; nothing less in fact than the direct contradiction of the general proposition which is at the basis of the law of the survival of the fittest, viz., that what is good for the individual is good for the race. Some have questioned the validity of this so far as its application to certain phases of our social and institutional life is concerned, but I have yet to learn of any serious doubt having been cast upon it in its bearing upon the organic evolution of animal forms under natural conditions. Yet under the artificial condition of the removal of diseased parts in order that the life of the individual may be prolonged we have precisely this. In order to give the discussion concreteness let us consider the possible racial effects of the now common operation for appendicitis. Since the old theory of foreign lodgments—grape stones and the like—in the appendix as the cause of the trouble has been proven false, at least in a vast majority of cases, we are forced to consider appendicitis a disease; an inflammation of a particularly serious nature, yet no more accidental in its origin than are similar congestions in other parts of the body. But

scientists tell us that diseases of all sorts—at least the predisposition to them—are transmissible; that they run in families, and that the probability is greater that the children of diseased parents will fall heir to the particular maladies of the latter than that the children of unaffected parents will be troubled by them. It is true that in the case of appendicitis, recent acquisition as it is to the catalogue of bodily ills, we have no exact data in support of the belief that it is transmissible, yet reasoning from analogy we have every right to believe that it is so. A hereditary predisposition to many other forms of inflammation similar in all respects except that of the part affected has been fully demonstrated and the inference is certainly a logical one that appendicitis is no exception to the rule.

But under the conditions of nature, such a transmission of disastrous predispositions is taken care of through the early death of the individual with the consequent impossibility of passing them to the descendants. If death comes before the period of maturity is reached the lack of offspring means the total annihilation so far as the race is concerned, of disastrous consequence in that particular line of descent. If it comes early in maturity such annihilation is not absolute but only relative, the danger to the race increasing with the length of life as measured by the number of children. In any event nature demands death without offspring on the part of the individuals possessing racially disastrous predispositions. Yet that is what the prolongation of life through surgical intervention controverts. All danger of death from the particular diseased part, so far as the individual is concerned, is removed without lessening seemingly one whit its disastrous effects upon the race. A long life is assured so far as the particular disease is concerned and, all other things equal, a correspondingly large family with all the laws of heredity potent, so far as the probable transmission of the difficulty is concerned. To believe that the surgical removal of the diseased part does away with the probability of the transmittal of the disease would be to accept the theory of the transmission of mutilations. This, few thinking persons, familiar with the field of scientific thought, are willing to do. Generations of artificially misshapen heads among certain savage tribes, of the mutilated feet of the Chinese women without racial effect, to say nothing of the lack of results of century upon century of circumcision, are all in opposition to it. And the corollary is that the good offices of the surgeon—whom, by the way, we shall probably continue to patronize in spite of any disaster we may see impending future generations—are the surest means of making permanent his calling. That this is true in the case of appendicitis is more easily seen than for other surgically prevented diseases, for we can not doubt that nature, left to herself, would in time eliminate the vermiform appendix altogether with the consequently disastrous results to the surgeon's income. We need not, however, impute to him any sordid motives when we say that he is taking the surest means of preventing such a catastrophe.

Edwin G. Dexter.
The University of Illinois.

'THE TREE-DWELLERS.'

To the Editor of Science: Since the two articles which have appeared in recent numbers of Science regarding 'The Tree-dwellers' contain several statements not supported by facts, and since the criticisms made rest largely upon a hypothetical basis, it may not be out of place to call attention to the same through the columns of the paper in which the articles appeared. The articles referred to are a letter from Dr. E. C. Case, State Normal School, Milwaukee, Wis., published in Science, April 1, and an article by Dr. Theo Gill, entitled "'Horses' not Horses," appearing May 6.

At the outset I wish to acknowledge an indebtedness to Dr. Case, for it was his criticism which first called my attention to the possibility of making the startling interpretation which he makes of the illustration on page 67, which he refers to as a Jurassic dinosaur chasing an Eocene horse, and the illustration on page 62 which he refers to as 'a man in a tree watching a herd of the same horses (?) that were pursued by the Jurassic dinosaur!' Dr. Case continues, 'This makes

man contemporaneous with the dinosaur, although it is not so stated in the text.'

The attempt to avoid many words unfamiliar to children led to the use of the term 'horse' on pages 66 and 67 where 'mammal' or 'ancestor of the horse' would have been more exact. The lesson in question was intended merely to give some such general conception as Professor N. S. Shaler gives in his chapter on the horse in 'Domesticated Animals,' pages 58–9, where he states: "In the first stages of the Tertiary period, in the age when we began to trace the evolution of the suck-giving animals above the lowly grade in which the kangaroos and opossums belong, we find the ancestors of our mammalian series all characterized by rather weakly organized limbs fitted, as were those of their remote kindred, the marsupials, for tree-climbing, rather than for running over the surface of the ground. *The fact is that all the creatures of the great clan acquired their properties of body in arboreal life, and with such relatively small and light bodies as were fitted for tree-climbing.*"

In so far as the illustration on page 67 conveys the idea that the remote ancestors of the horse and other mammals once lived in proximity to dinosaurs and were preyed upon by these creatures, it is true to the facts. Its defects consist in the fact (1) that the form of the mammal in question resembles too closely that of the Eocene horse, and (2) the hind limbs of the dinosaur are not as long as the skeletons indicate.

Although the dinosaur in question lived in the Jurassic period, as Dr. Case states, carnivorous dinosaurs were abundant in the Cretaceous and did not become extinct until the end of that period. When this fact is taken into account, and when it is remembered that the most eminent paleontologists still expect to find in the Cretaceous rocks forms intermediate between the Jurassic mammals and the Eocene types, the reader can better appreciate the point of view of the author in presenting the lesson as it appears in the first edition. But the illustration is defective and it will not appear in the second edition. The two lessons on the wild horse, including the remote ancestors of the horse, have been revised, and although the ideas used are substantially the same, it is hoped that they are expressed in a form which will not offend the genuine student of science. It must be remembered, however, that the nature of the work precludes the use of technical terms.

The horses represented in the illustration on page 62 are intended for Pleistocene horses and are briefly described at the foot of page 70 and on page 71. It may be due to the stripes, which are hypothetical, and to his interpretation of the perspective of the picture, that have led Dr. Case to interpret the horses as Eocene forms. Although this picture is not incorrect, it will be replaced by one which can not be interpreted in such a way.

Had Dr. Case read the text more carefully he might still be in doubt regarding the time relations of the dinosaur and the ancestors of the horse on account of my use of the term 'horse' on pages 66 and 67. But he surely could not have failed to see that man's relation to these primitive forms is distinctly stated, even though technical terms are avoided. For instance, the first line of the text quoted by Dr. Case should make clear that the animal described in the following lines lived long before man appeared. Again, at the foot of page 70 and the top of page 71 the form of the horse which was contemporaneous with man of the mid-Pleistocene period is clearly stated. Had this not been sufficient, Dr. Case could have found two notes of warning against such an interpretation as he has made, on pages 146 and 154.

The real evidence, then, upon which the criticisms of Dr. Case thus far considered rest, is this: The defects pointed out in the illustration on page 67, and the use of the term 'horse' in a sense wide enough to include the remote ancestors of the horse. The evidence which he has neglected is *the text itself*.

In view of the well-established and readily available statements concerning the discoveries of Professor Cope in the United States, and Professor Boyd Dawkins in Europe, with reference to the hairy mammoth and the sabre-toothed *Felis* (*Machairodus*), it is difficult to understand how Dr. Case could venture the

criticism, 'This book is filled with just such mistakes throughout, notably a figure of a sabre-toothed tiger in fierce combat with a hairy mammoth.' Near the town of Hennessey, Oklahoma, Professor Cope obtained teeth and bones of the mammoth associated with the bones of a sabre-toothed cat as large as a lion, as though 'death had overtaken it while feeding upon the carcass of the mammoth' (*J. Acad. of Nat. Sci.*, Phil., IX., page 453.) It is doubtless unnecessary to state that the illustration will stand as an accurate portrayal of a combat which man of the mid-Pleistocene period undoubtedly witnessed many a time.

Since Dr. Gill's criticisms appear to be based upon the statements made in Dr. Case's letter and not upon an examination of the book at first hand, they need little attention. There are a few statements, however, which the reader may be interested in comparing with statements of other eminent scientists.

Dr. Gill states, 'But no ungulate in the line of the horse with five toes has been discovered.' Professor Cope writes ('Origin of the Fittest,' page 301): "*Phenacodus* is antecedent to all the horse series, the elephant series, the hog, the rhinoceros and all other series of hoofed animals. It has five toes on all of the feet."

Again Dr. Gill writes: 'Another pure assumption is that the primitive equoidean animals lived especially in the marshes.' Professor Huxley in his American Addresses, refers to the Eocene horses as 'the short-legged, splay-footed plodders of the Eocene marshes.' Professor Cope writes ('Origin of the Fittest,' page 374): "* * * the types with reduced digits are dwellers on dry land in both orders, and those that have more digits are inhabitants of swamps and mud. * * * Certain it is that the lengths of the bones of the feet of the ungulate orders have a direct relation to the dryness of the ground they inhabit, and the possibility of speed which their habitat permits them, or necessarily imposes on them." (See, also, Mr. Lucas's statement, *McClure's Magazine*, volume 15, page 517.)

Still again Dr. Gill writes, 'But there is no need of confining such animals to the marshes.' Had Dr. Gill read the next few pages of the text he would have been spared the trouble of making the remark.

Dr. Gill is certainly correct in stating, 'Every instructed zoologist would know that such a characteristic as five toes (or four) must necessarily be coordinate with innumerable modifications of other parts,' but one can scarcely be expected to present all of 'these innumerable modifications' to the child of seven years. In presenting a brief account of the changes that took place in the feet and in reserving the changes in the structure of the teeth for a later period, I find support in the statement of Professor Cope ('Origin of the Fittest,' page 269), where he states, "The primary forms of mammalia repose in great measure on the structure of the feet. Those of the teeth are also significant, but present a greater number of variations among animals otherwise nearly related."

While not a specialist in paleontology or in several of the sciences to which I find it necessary to go for materials, I have taken great pains to secure reliable data, and to consult with specialists concerning the same. Since Dr. Case's criticism was made, Dr. S. W. Williston, professor of paleontology of the University of Chicago, has kindly examined 'The Tree-dwellers' from the point of view of the paleontologist; and he has given me permission to state this fact in this letter and in the preface to the second edition of the book. In view of the fact that Dr. Case states that the book is filled with glaring errors, the reader may be interested in knowing that Professor Williston has authorized me to state that aside from the changes made in the lesson on the wild horse referred to above, the changes he suggests are few and unimportant.

It is too much to expect a series of books which represents such a radical departure from traditional text-books for children as this series does, to pass unchallenged. But this is not a matter to be regretted. That which causes one to review one's work, to weigh evidence more carefully, to eliminate errors, to reconstruct in the light of a higher truth, should be welcomed by all. A careful examination and criticism of the series is invited, with the assurance that the points which

are brought to the attention of the author will receive due consideration.

KATHARINE E. DOPP.

EXTENSION DIVISION,
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SPECIAL ARTICLES.

MONT PELÉ FROM OCTOBER 20, 1903, TO MAY 20, 1904.

THE publication in the daily papers of the statement that Mt. Pelé had celebrated the second anniversary of the destruction of St. Pierre by a heavy eruption, has renewed popular interest in the volcano. A few days before the appearance of this item, the author received, from a correspondent in Dominica, information that Mt. Pelé had been in serious eruption on May 8 and had blown out the new central cone. Inquiry at the office of the American Trading Co. in this city elicited the statement that letters from their representative in Martinique, under date of May 11, made no mention of the volcano, which would hardly have been the case had there been a great eruption.

To-day copies of the *Journal Officiel de la Martinique* for May 10 to 20 have come to hand and the following quotation (translation) of the 'Bulletins concernant le volcan' will be of interest:

May 4 to 6, 1904.—Mountain almost constantly covered. Discharge of vapor moderate. A few rather heavy rumblings from time to time. Some shattering was produced at the top of the dome. The height has slightly diminished.

May 6 to 8, 1904.—Mountain constantly covered. Discharge of vapors very feeble Saturday morning, becoming rather abundant Saturday evening and Sunday (8th). Several discharges (flows) accompanied by rather heavy rumbling.

May 8 to 9, 1904.—Mountain remained constantly covered. Discharge of vapor rather abundant.

May 9 to 10, 1904.—The mountain which was covered in the morning, became clear after five o'clock in the afternoon. Moderate discharge of white vapors. Several rumblings. The summit of the dome has risen about five meters since April 26.

May 11 to 12, 1904.—Mountain covered during the day and free from clouds at night. Moderate discharge of white vapors. Frequent rumblings. Yesterday evening from 5:30 to 6 o'clock outbursts of rather thick red clouds to slight elevations succeeded one another almost without interruption from the southeast side. At 7:45 a rather bright luminous point appeared near the middle of the dome.

May 12 to 13, 1904.—Mountain clear in the afternoon. Rather abundant discharge of white vapors mixed with red vapors. Several rumblings, one of which was very heavy, yesterday at 10:25 P.M.

May 13 to 15, 1904.—Mountain almost constantly covered Saturday and uncovered yesterday. Several low outbursts of red cloud. Many rumblings. Moderate discharge of vapors. Yesterday morning at 9:50 a dust-flow of slight extent descended slowly as far as the base of the talus of débris.

May 17 to 18, 1904.—Mountain almost constantly covered. Some flows and rumblings Monday. Nothing noteworthy yesterday.

May 18 to 19, 1904.—Mountain constantly covered. Nothing to note.

(Signed) PERNET.

Since October 19, 1903,* the history of Mont Pelé has not been characterized by any very startling events. The dome which has formed the summit of the mountain since the famous spine or obelisk was destroyed in August, 1903, has suffered many minor changes in altitude and form which have altered its appearance entirely from what it was at the beginning.

The history of the dome, as gathered from the *Journal Officiel*, is as follows:

October 21, 1903.—Loss of 5 m.

October 22.—Loss of 3 m.

October 25.—Slight modifications.

October 26.—Additional modifications.

October 29.—The dome has suffered certain changes; its height has been stationary for several days.

November 3.—The dome has suffered certain modifications of form without change in altitude.

November 5.—A considerable portion of the dome was blown off at 11:34 A.M.

November 8.—The dome rose 4 m. between the 6th and 8th.

November 10.—The dome seems to be destined to rapid disappearance on account of successive outbursts on the southwestern side.

* See Hovey, 'Mont Pelé from May to October, 1903,' SCIENCE, N. S., Volume XVIII., p. 633, November 13, 1903.

November 11.—A needle, 15 m. in height, which existed on the western part of the summit of the dome, has disappeared.

November 15.—The dome has suffered rather extensive changes.

November 16.—The summit of the dome has undergone additional modifications.

November 22.—At 8:30 A.M. an outburst destroyed a noteworthy portion of the dome.

November 27.—Loss of 3 m. in altitude.

November 29.—Additional modifications of the dome reported.

December 2.—The dome has suffered important changes and has lost through outbursts 10 m. of altitude.

December 10.—A large mass was blown off from the eastern side of the dome.

December 11.—Loss of 8 m. in altitude.

December 13.—Additional changes on the eastern side.

December 17.—Certain changes of form.

December 27.—Slight modifications noted.

December 31.—Loss of 3 m. since the 26th.

January 3, 1904.—The dome has undergone many changes. The remains of the ancient spine rise rather rapidly while the other parts of the dome, which seem stationary, are reduced by almost continual avalanches.

January 7.—A part of the dome has risen 3 m. since the 2d.

January 8.—Rise of 3 m.

January 12.—Slight modifications without change of altitude.

February 3.—Slight modifications.

February 25.—Modifications of form without change of altitude.

February 28.—A large mass fell.

March 6.—Loss of 3 m. in altitude since January 25. The southern portion of the dome is reported partly destroyed.

March 13.—The altitude of the dome is reported stationary.

March 17.—Sensible modifications noted.

March 27.—Gain of 3 m. since the 18th.

March 29.—Some modifications of form without change of altitude.

April 3.—Rise of 3 m. since March 27.

April 15.—The summit of the dome has risen about 5 m. since April 3.

April 20.—Rise of 3 m. noted.

April 25.—The summit of the dome has risen about 5 m. since April 20.

May 6.—Slight loss of altitude.

May 10.—Rise of 5 m. since April 25.

May 20.—Gain of about 5 m. since May 10.

Summarizing the foregoing notes, there was a continual loss of altitude of the dome from October 19 to December 31 inclusive, with the exception of three days in November when the dome rose 4 m. The net loss of altitude in this period appears to have been about 28 m. The daily bulletins are unsatisfactory in that 'modifications' are noted from time to time without any statement as to their character.

On January 3, Professor Giraud reports the important fact that the remains of the great obelisk which towered above the volcano in the early part of 1903, were again rising with reference to the remainder of the new cone. The daily reports from that time on say nothing further, however, with regard to the spine. A period of elevation set in with the beginning of January, 1904, with a rise of 6 m. during the first eight days of the year. Then for eleven weeks, the altitude remained stationary, except for a loss of 3 m. during the first week in March. With the 27th of March, the rise seems to have become nearly continuous and amounted to 29 m. in eight weeks (to May 20), giving a net gain of 32 m. since January first.

Whether this applies to the summit of the new spine which was reported rising early in January or not, the losses which took place in the altitude of the mountain during the last months of 1903 were regained during the first five months of the present year.

The activity of the volcano, which was so great during September, 1903, as to seem to threaten a first-class eruption, gradually diminished during the last quarter of the year, and there have been apparently few noteworthy outbursts to chronicle during the past four or five months. Few days, however, pass without clouds of steam rising from the crater, accompanied from time to time by dust-flows down the gorge to the Rivière Blanche to the southwest or across the basin of the Lac des Palmistes to the east.

Edmund Otis Hovey.

American Museum of Natural History,
New York, June 11, 1904.

THE OCCURRENCE OF TAURIN IN INVERTEBRATE MUSCLE.

A RECENTLY published paper by Agnes Kelly* on the occurrence of taurin in *Pecten opercularis* and *Mytilus edulis*, leads me to announce a similar observation on the occurrence of taurin among the muscle-extractives of *Sycotypus canaliculatus* and *Fulgur carica*, the zinc-bearing gastropods of Long Island Sound.†

Taurin has been described as a constituent of invertebrate muscle since 1845, when Karsten isolated a crystalline body from the watery extracts of certain molluscs, and identified it with the taurin separated from bile. Since that time the list has been largely extended by Krukenberg and others, until it includes the following molluscs: *Doriopsis, Turbo, Cassidaria, Mytilus, Ostræa, Pinna, Arca, Spondylus, Pectunculus, Pecten, Murex, Octopus, Loligo* and *Sepia*.

In a physiological-chemical study of various molluscs, which has been in progress in this laboratory for some time, under the direction of Dr. Mendel, taurin was separated in its characteristic crystal form, which, together with its sulphur content and chemical reactions, left no doubt in regard to its identity. This was further established by an analysis, which gave the following results:

	N.	S.
Calculated for $NH_2.CH_2.CH_2.SO_3H$	11.22%	25.62%
Found	11.37%	25.89%

Taurin has also been obtained from the muscles of *Haliotis*, the 'abalone' of the Pacific coast, by Professors L. B. Mendel and M. E. Jaffa, and likewise identified by analysis.

The finding of taurin—amido-ethyl-sulphonic acid—among the products of muscle katabolism in invertebrates is of particular physiological interest in view of the close relationship which has recently been shown to exist between taurin, cystin and the proteids.‡

The apparent association of taurin and glycocoll—amido-acetic acid—in molluscs, recalls the related occurrence of derivatives of these compounds in higher organisms.

HAROLD C. BRADLEY.

LABORATORY OF PHYSIOLOGICAL CHEMISTRY, SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY, NEW HAVEN, CONN.

* Agnes Kelly, 'Hofmeister's Beiträge zur chemischen Physiologie,' V., p. 377, 1904.

† Cf. SCIENCE, Vol. XIX., No. 474, January 29, 1904.

‡ Friedmann, 'Ergebnisse der Physiologie,' 1902–3, I., 1, and II., 1.

THE PTERIDOSPERMAPHYTA.

SUCH is the name that I would propose to give to those plants, long extinct though they may all be, having the general character of Pteridophyta, but bearing seeds as in the Spermatophyta.* Such forms are now rapidly coming to light and are too well known to botanists to require enumeration. The name Cycadofilices which has been applied to them seems objectionable in several respects. While most of them do partake of the nature of both cycads and ferns, it is not certain that all do so, and additional ones may not entirely justify this designation. It is probable that they may, if some already known do not now, show affinities with the Pinales as well as with the Cycadales, and it is not at all improbable either that calamarian forms will be found with true seed vessels. A name is needed that shall express the broader fact that the ancient Pteridophytes occasionally developed so far in their reproductive system that they take on the characters of Spermatophytes. The term Pteridospermaphyta expresses this truth. It is somewhat long, but not longer than a number of the terms used in current systems of classification for which there are far less cogent reasons. It has the further advantage of denoting the true order or direction of development, and not the inverted order denoted by the term Cycadofilices.

The Pteridospermaphyta constitute a *phylum* coordinate with the Pteridophyta and Spermatophyta. They mark the progress of plant development from the standpoint of the reproductive organs. It is true that they bridge over a great chasm hitherto supposed to be impassable, but this is what we ought to expect as the knowledge of nature increases.

* This term is shortened by some writers to Spermaphyta.

Just as the discovery of the exogenous structure in many Carboniferous Pteridophytes (*Calamites, Stigmaria, Sigillaria,* even *Lepidodendron*) overthrew the old Lindleyan classification into endogens and exogens, which was supposed to be fundamental, so the discovery of the Pteridospermaphyta causes the later classification into spore-bearing and seed-bearing plants, which was confidently believed to constitute a durable substitute, to break down, and we are in the presence of the important truth that in both their internal structure and their floral structure the early types of vegetation advanced during Paleozoic time to a position not essentially different from that of the more developed types of the present day.

Lester F. Ward.

INFLUENCE OF BORIC ACID AND BORAX ON DIGESTION AND HEALTH.

Bulletin No. 84 of the Bureau of Chemistry, now in press, is the first of a series of monographs from that bureau embodying investigations made in accordance with the following authority contained in the act of Congress making appropriations for the Department of Agriculture, to wit: "To enable the Secretary of Agriculture to investigate the character of food preservatives, coloring matters, and other substances added to foods, to determine their relation to digestion and health, and to establish the principles which should guide their use."

These investigations were commenced in the autumn of 1902 under the direction of Dr. H. W. Wiley. Previous to their beginning a careful study of similar work done in this and other countries was undertaken and some of the laboratories where this work had been carried on, notably the laboratory of the Imperial Board of Health of Germany, at Charlottenburg, were visited and the method of experiments investigated. The plan finally decided upon was to secure the voluntary services of a number of young men who would undertake to try the effect of the added substances upon their digestion and health, to make the necessary observations, and to submit themselves to the rigid analytical control which such a series of investigations required.

The number finally selected for experiment was 12, as this was found to be about the maximum number which could be cared for with the analytical and culinary facilities afforded by the Bureau of Chemistry. A kitchen and a dining room were fitted up in the basement of the bureau and in December, 1902, the actual experimental work began and it continued, in the case of boric acid and borax, until July 1, 1903. The work was so divided that no one of the young men under observation was required to submit himself to the rigid control necessary to the conduct of the work more than one half of the time. The men selected were taken partly from the force of the Bureau of Chemistry and the rest from other Divisions and Bureaus of the Department of Agriculture. Each one was required to subscribe to a pledge to obey all the rules and regulations prescribed, and to abstain from all food and drink during the period of observation save that which was given him in the course of the experiment. Careful medical inspection of each of the members of the experimental class was secured, both directly and by collaboration with the Public Health and Marine Hospital Service. The details of the work, both analytical and medical, are found in full in the bulletin above mentioned which is now in press. Some of the conclusions are as follows:

When boric acid or borax equivalent thereto, in small quantities not exceeding a half gram per day, is given in the food no notable effects are immediately produced. If, however, these small doses be continued for a long while, as for instance in one case 50 days, there are occasional periods of loss of appetite, bad feeling, fulness in the head, and distress in the stomach. These symptoms, however, are not developed in every person within the time covered by the experiment, for some are far more sensitive to the action of these bodies in small quantities than others.

When boric acid, or borax in equivalent quantities, is given in larger and increasing doses there is a tendency to the somewhat rapid development in a more accentuated form of the symptoms above described. The most common symptom developed is a persistent

headache, a sense of fulness in the head, with a clouding to a slight extent of the mental processes. When the doses are increased to 3 grams a day these symptoms are established in a majority of the cases but not in every case. They are also sometimes attended by a very distinct feeling of nausea and occasionally by vomiting, though the latter act is rarely established. There is a general feeling of discomfort, however, in almost every case, but the quantities required to establish these symptoms vary greatly with different individuals. In some cases very large quantities may be taken without the establishment of marked symptoms, while in other cases from 1 to 2 grams per day serve to produce in a short time feelings of discomfort and distress.

No conclusions were reached in regard to smaller quantities than half a gram per day of the preservative, and, therefore, any statements in regard to the administration of smaller quantities must be based largely upon the results obtained with the quantities actually employed. It is reasonable to infer that bodies of this kind not natural to nor necessary in foods which exert a marked injurious effect, when used in large quantities for short periods of time, would have a tendency to produce an injurious effect when used in small quantities for a long time. The general course of reasoning, therefore, would seem to indicate that it is not advisable to use borax in those articles of food intended for common and continuous use. When placed in food products which are used occasionally and in small quantities it seems only right, in view of the above summary of facts, to require that the quantity and character of the preservative, that is, whether borax or boric acid, be plainly marked so that the consumer may understand the nature of the food he is eating.

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*LABORATORIES FOR BOTANICAL RESEARCH.**

THE publicity given to the opening ceremonials of the new science laboratories at Cambridge by the king and queen on March 1 will, it may be hoped, do something to rouse those who are responsible for the welfare of the nation to a wider sense of their duties. The time has surely passed when the remarks of a well-known prelate and of a prime minister, to the effect that they were born in a pre-scientific era, could be received, if not with overt applause, at least with sneaking sympathy.

Sluggish as we are, some progress has been made. Up to the middle of the last century, and for some time after, there was scarcely a botanical laboratory properly so called in the whole country. Now we have the Jodrell Laboratory at Kew, a very modest institution when compared with the necessities of the case or to the excellent equipment of other departments of this great national establishment. The Jodrell Laboratory is not intended for instructional purposes, but chiefly for study and research, and much good work has been done there.

At Cambridge, Edinburgh, Glasgow, Dublin, at University College, London, the Royal College of Science, and in many other universities, agricultural colleges and technical institutes, there are now more or less well-equipped laboratories under competent direction. But these are mainly for the instruction of students. Research laboratories are still rare, and those willing and competent to utilize them are also few in number. This condition of affairs is largely due to the indifference and lack of encouragement on the part of those who ought to know better. The *cui bono* question is ever in their minds, and much too frequently on their lips. Abstract science does not appeal to their sympathies, or to their intelligence, unless some immediate practical result at once comes into view. When that happens the commercial instinct may perchance be aroused, and they begin to ask, will it pay? Of course, no reader of this journal is likely to undervalue abstract science, and most of them are well aware of the enormous value of the practical results that may and do result from it. But even such persons must have been startled to find how the observations of Bower and others on the minute anatomy of the prothallus and spore-producing tissues of ferns, observations which might have been thought to be too abstruse and recondite to be of any practical value whatever, have directly led up to the

* From *Nature*.

extremely important researches of Farmer and his associates into the essential nature of cancer!

Satisfactory as this undoubtedly is, we have only to look across the channel to see how puny—numerically and financially speaking—are our efforts to promote original research. Our cousins across the Atlantic, a practical people if ever there was one, are even more energetic. Does a 'freeze' destroy or seriously injure the oranges of Florida, what matter? In a very short time a man of science and a man of resource is on the spot. He looks for and finds a hardy stock whereon to graft the tender scion, he puts the resources of hybridization to the test in the endeavor to procure hardy seedlings. All this is done at once by state or government agency. Here, if anything were tried in a parallel case, it would be with great deliberation and with little or no encouragement or support.

Those familiar with what is done to promote research in the universities and colleges of the United States, as at New York, Chicago, Philadelphia and in California, not to mention the older foundations of Harvard and Yale, must feel almost aghast at the progress that is being made, and at our own backwardness. In the *Gardeners' Chronicle* for January 30 is an article contributed by a well-known professor familiar with what is being done here as well as there. In that article he gives details as to the astonishing activity manifested in the American universities, mainly by the aid of funds provided by private individuals. We too have reason to know and appreciate what is done by the government agricultural department, and by the very numerous experimental stations scattered all over the wide territories of the United States.

As we write, there comes to us a report of the establishment, under the auspices of the Carnegie Institution, of a 'desert botanical laboratory, the purpose of such establishment being to study thoroughly the relation of plants to an arid climate and to substrata of unusual composition.' A laboratory has accordingly been erected near Tucson, in Arizona, under the management of Dr. W. A. Cannon, of the New York Botanical Garden, who has been appointed resident investigator in charge of the laboratory. What may be described as a sort of preliminary report has been drawn up by Mr. Coville and Dr. MacDougal, and a very interesting and copiously illustrated report it is.

As some of our readers may care to see this publication, we may add that it is issued by the Carnegie Institution of Washington, U. S. A. (publication No. 6).

Vast as is their territory, and numerous as are their experimental stations and like institutions, our cousins are not yet satisfied. They have invaded British territory, in a most genial and friendly manner it is true, but still they have annexed, with our consent, a portion of the island of Jamaica, and there they have established, at 'Cinchona,' a botanical laboratory and research station open to the students of all countries. The direction is in the hands of Dr. Britton, of the New York Botanical Garden, in cooperation with Mr. Fawcett, the director of public gardens and plantations in the island. The policy of the 'open door' pursued by the Americans in these matters prevents us from doing anything but acquiesce in their proceedings. But why what should have been a plain duty for us should have been allowed to be undertaken by others is a mystery.

We do not question the utility of ironclads and cruisers as protectors of our commerce, but it is obvious to those who are watching the proceedings of our neighbors and of our rivals that if we do not largely extend our scientific training and induce our wealthy citizens to follow the example of their American brethren in endowing science, the necessity for protection will vanish, and that not slowly.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

The International Council met on Monday, May 23, and Tuesday, May 24, 1904, at the Rooms of the Royal Society of London, and transacted business as follows:

On the motion of Dr. Uhlworm, Professor H. E. Armstrong was elected chairman of the meeting and Dr. H. Forster Morley secretary.

On the motion of Dr. Blanford, it was resolved: That the report submitted by the executive committee be received and adopted for presentation to the Regional Bureaus.

The council authorized the distribution of the balance sheet to the several regional bureaus for publication in some recognized periodical in each of the constituent regions, in accordance with the regulation laid down at the Third International Conference.

On the motion of the chairman, it was resolved: That, in view of the success already achieved by the International Catalogue of Scientific Literature, and of its great importance to scientific workers, it is imperative to continue the publication of the catalogue beyond the first five annual issues. That this Resolution be communicated to the Regional Bureaus, requesting them to bring it under the notice of the contracting bodies and to obtain the necessary guarantees for the continuance of the work.

It was resolved: That the executive committee be authorized, in consultation with the Regional Bureaus, to spend a sum not exceeding £100 in making the catalogue known.

On the motion of the chairman it was resolved: That a representative of Russia be added to the executive committee, and that steps be taken to invite countries not yet represented on the Catalogue (Spain, Balkan States and South American Republics, etc.) to establish Regional Bureaus.

It was resolved: That the council accede to an application of the University of Ottawa, Canada, for the replacement of volumes of the catalogue lost in a conflagration which destroyed the whole of the university buildings including the library.

A motion by Professor Korteweg to place copies of the catalogue at a reduced price at the disposal of the regional bureaus for the use of the experts was discussed and withdrawn, the feeling being that, although desirable, the financial position of the catalogue did not yet admit of such a step being taken.

The proposal to extend the scope of the catalogue by the publication of additional series of volumes dealing with such subjects as (*a*) Medicine and Surgery, (*b*) Agriculture, Horticulture and Forestry, (*c*) Technology (various branches), was discussed, and the opinion expressed that it was desirable that the executive committee should take the matter into further consideration, in order that it may be brought under the notice of the International Convention in July, 1905.

It was resolved: That all alterations proposed in the schedules shall be collected and edited by the central bureau; that the amended schedules, together with the proposals of the bureaus, shall be submitted to the regional bureaus for their opinion; and that the final editing of the schemes to be submitted for the approval of the International Convention be entrusted to a committee of five persons, to be nominated by the executive committee.

SCIENTIFIC NOTES AND NEWS.

THE University of Michigan has conferred its doctorate of laws on Dr. F. H. Gerrish, professor of anatomy in Bowdoin Medical College.

THE degree of doctor of science has been conferred by Lafayette College on Francis P. Venable, president of the University of North Carolina and formerly professor of chemistry.

THE Western University of Pennsylvania, at its commencement held on June 16, conferred the degree of Sc.D. on Mr. Frank Hurlbut Chittenden, assistant entomologist of the United States Department of Agriculture, Washington, D. C.

THE University of Dublin has conferred the doctorate of science as follows: J. Dewar, Jacksonian professor of experimental philosophy, Cambridge, and Fullerian professor of chemistry at the Royal Institution; Professor J. H. van't Hoff, Berlin; Professor F. Klein, Göttingen; Major R. Ross, C.B., F.R.G.S., professor of tropical medicine, Liverpool; J. J. H. Teall, F.R.S., director of the Geological Survey of the United Kingdom; W. H. Thompson, King's professor of the institutes of medicine.

DR. J. T. ROTHROCK has, owing to ill health, resigned the position of forestry commissioner of the state of Pennsylvania. Mr. R. S. Conklin, present deputy commissioner, has been appointed his successor.

Professor V. M. Spalding, of the University of Michigan, has received a grant from the Carnegie Institution for the continuance of an investigation at the Desert Laboratory of the absorption and transpiration of water by the creosote bush and other desert shrubs. He will be located at Tucson, Arizona, during the winter of 1904–5.

The office of Vegetable, Physiological and Pathological Investigations of the Bureau of Plant Industry has arranged with Professor L. R. Jones, of the University of Vermont, to do some special work on the diseases of the potato. Professor Jones has been instructed to obtain all available information in regard to European varieties, and to obtain seed tubers of valuable sorts, especially disease-resistant strains, for testing in various sections of the United States. He has been appointed a temporary special agent of the Bureau of Plant Industry of the Department of Agriculture for this purpose and is now in Europe engaged in the work.

Mr. Thomas Manns, of the North Dakota Agricultural College, has resigned his position as instructor in botany and has accepted a position with the War Department in the Philippines. During the past two years Mr. Mann has been conducting investigations upon soil fungi as affecting the character of the crops upon the rotation plots of the Experiment Station. The results of this work are very promising and the board of trustees have instructed Professor H. L. Bolley of the department of botany to find a young man to continue the work.

Dr. J. W. Lowber, F.R.A.S., of Austin, Texas, has been elected a member of the Belgian Astronomical Society, Brussels.

Professor Henry Landes, head of the department of geology in the Washington State University, who has been absent studying at the University of Chicago during the year, will resume his work in Seattle next September.

Professor Alexander L. Nelson has celebrated the fiftieth anniversary of his professorship of mathematics at Washington and Lee University.

At the alumni dinner of the State University of Iowa, the former students of Professor Samuel Calvin, to the number of over two thousand, united in the commemoration of the completion of his thirtieth year in a professorship at that institution. The recognition took the form of a costly silver loving-cup, designed especially for the purpose of symbolizing the scientific achievements of the recipient. The cup is a classic Greek vase sixteen inches in height, and stands on a base of serpentine five inches high. It is adorned with casts taken directly from fossils, with a drainage-map of Iowa, with crossed geological hammers, a microscope, and the more conventional spray of laurel, owl of wisdom and torch of learning, —all in relief. One side bears an appropriate inscription in raised letters. Professor Calvin was elected to the chair of natural history in Iowa's university thirty years ago. The chair has since been subdivided into four distinct departments, Professor Calvin retaining the department of geology. He has been state geologist of Iowa during the last twelve years.

The Warren Triennial Prize of the value of $500, in the gift of the Massachusetts General Hospital, has been awarded to Dr. Max Borst, extraordinary professor of pathological anatomy in the University of Würzburg, for a dissertation entitled 'Neue Experimente zur Frage der Regenerationsfähigkeit des Gehirns.'

Dr. N. S. Davis, of Chicago, died on June 16, aged eighty-seven years. Dr. Davis was a voluminous writer on medical subjects and took an important part in the organization of the medical profession. He was, in 1845, chairman of a committee whose report led to the establishment of the American Medical Association, and he was the first editor of its journal.

Mr. Andrew Carnegie has given £1,200 to the Royal Institution, to enable Professor Dewar and Mr. R. A. Hadfield to prosecute their investigation on the physical properties of steel and other alloys at low temperatures; Dr. Frank McClean has given £100 to the research fund of the institution.

It is said that Colonel Gorgas, chief sanitary officer of the Isthmian Canal, estimates

that three hundred special physicians will be required during the progress of the war. These physicians will be in addition to surgeons of the army and navy, and will be selected from those who have recently graduated and completed hospital service.

THERE is wanted an economic geologist and paleontologist in the Mining Bureau at Manila, P. I., the salary of the position being $2,000. Applicants must satisfy the U. S. Civil Service Board, but should write directly to the Chief of the Mining Bureau, Manila, P. I.

WE learn from *Nature* that a meeting of members of the council of the South African Association for the Advancement of Science was held at Johannesburg, on May 19, Mr. T. Reunert presiding. The chairman reported that he had been in communication with the German, French, Austrian and Italian consuls, and was hopeful of the cooperation of these gentlemen in connection with the visit of continental delegates to South Africa with the British Association next year. Dr. Pakes, referring to the impending departure of Mr. Reunert for England, mentioned that he would represent the South African Association at the forthcoming Cambridge meeting of the British Association.

THE Institution of Civil Engineers gave a *conversazione* on June 15 at the institution premises. The guests, who numbered about 1,200, were received by Sir William H. White, the president, and Lady White and the members of the council.

THE *Discovery* and the *Morning* have sailed from Lyttleton, New Zealand, for Plymouth.

The British Medical Joural states that a number of French medical men who take an interest in English medicine and surgery propose to visit London next October in order to see something of the hospitals and laboratories. An influential committee has been formed in Paris, and a small organizing committee, of which Dr. Triboulet is president. Among the senior members of the Paris faculty who have expressed their intention of joining the party are Professors Bouchard, Lucas-Championnière, Chauffard, Landouzy, Lermoyez, Marie and Sebileau.

A LETTER from Dr. C. Nordmann to the *Revue générale des Sciences,* abstracted in *Nature,* describes a new astrophysical observatory which has just been built near to Tortosa, in Spain, in latitude 40° 48′ N. and longitude 1° 47′ E. of Paris. The general idea of the work to be prosecuted is to obtain information regarding the relations between solar and terrestrial phenomena. Two magnetic houses have been equipped, the one for absolute measures of terrestrial magnetism, the other for obtaining records of the regular variations in the elements and of the extraordinary disturbances which appear to coincide, in point of time, with solar disturbances. The observatory is also to be furnished with an equatorial for observing sun-spots, an Evershed photo-spectroheliograph, and an instrument for determining the radial velocities of solar prominence eruptions. Another building has been set apart for meteorological observations and the study of atmospheric optics, and seismological observations have also been provided for.

THE committee appointed to enquire into the administration of the British Meteorological Council has made its report. We learn from the London *Times* that among its recommendations are the following: That the registration of the Meteorological Office as a company under the joint stock companies acts should be cancelled; that the company should be wound up, and the office reconstituted as a department under the control of the Board of Agriculture and Fisheries; that the office be placed under the control of a man of science as director of meteorology, appointed after consultation with the Royal Society, but responsible to the Board of Agriculture and Fisheries; that an advisory board be appointed, consisting of the hydrographer to the Admiralty, a representative of the Board of Trade, and one of the Board of Agriculture and Fisheries, and two members nominated by the Royal Society, the functions of the advisory board to be consultative only, the director being responsible to the Board of Agriculture and Fisheries for administration; that a second officer be appointed to act as scientific

assistant to the director; that the fixed Parliamentary grant of £15,300 be transferred to the vote for the Board of Agriculture and Fisheries; and that the post office should make arrangements at the 27 reporting stations in the United Kingdom for the transmission of daily telegraphic reports one hour earlier than the present one of 8:15 to 8:30 A.M., and that storm warnings should, if practicable, have priority over all private messages at all hours. The committee also call attention to the expediency of testing the efficacy of wireless telegraphy in providing advance news of weather in the Atlantic, and urge that no unnecessary delay should take place in organizing this experiment. They also recommend that in future the cost of instruments supplied to his Majesty's ships be borne upon the Navy Votes, except where such instruments are intended for use in research or observation specially called for by the director of meteorology, and they consider that the premises now rented by the council are neither suitable in character nor adequate in space for the present requirements of the office, and that others should be provided wherein the staff might perform their duties under more favorable hygienic conditions, and necessary accommodation for the rapidly growing library might be secured.

UNIVERSITY AND EDUCATIONAL NEWS.

THE new laboratory of physics and engineering, given by Mr. William H. Reid, of Chicago, to Washington and Lee University, was dedicated on June 15.

AT the recent commencement of the University of Nebraska three men graduated from the Department of Forestry which was established two years ago. These men on the establishment of forestry work in the university were transferred to this department from other departments of science, and thus were able to complete the course in two years. The full course is four years, and the requirements for admission to the freshman class are the same as for other departments of the university.

A DEPARTMENT of medicine with a two-years' course has been added to the curriculum of the Washington State University. For the present the work will be in charge of Professor Byers, head of the department of chemistry. Dr. C. W. Johnson, assistant professor of pharmacy, has been made dean of the department of pharmacy.

A MEDICAL department will be established next year as part of St. John's College, a catholic institution at Fordham, New York City.

THE Mercers' Company have given a donation of £1,000 to the Institute of Medical Science Fund (University of London), and the Clothworkers' Company have given £300.

MR. FRANCIS G. SMART, M.A., M.G., of Gonville and Caius College, has founded, in the University of Cambridge, a studentship of £100 a year, tenable two years, for the encouragement of botanical research.

IT is announced that work on the buildings for the Harvard Medical School has not progressed as rapidly as had been hoped, and that they will probably not be occupied until the autumn of 1906, instead of 1905, as was originally expected.

AT Cornell University, Mr. Carl P. Thomas, a graduate of the class of 1895, has been appointed assistant professor of marine engineering. Drs. James McMahon and John H. Tanner have been promoted to full professorships of mathematics.

DR. A. N. COOK, who has been professor of chemistry in Morningside College, Sioux City, for the past four years, has been elected professor of chemistry in the State University of South Dakota at Vermillion.

DR. C. H. GORDON, who has been acting professor of geology in the Washington State University during the past year, has accepted a call to the chair of geology in the New Mexico School of Mines.

MR. HARRY R. FULTON, assistant in biology in the University of Mississippi, has been awarded a fellowship in botany for 1904–5 in the University of Missouri.

DR. PHILIP HENRY PYE-SMITH, M.D., F.R.S., has been reelected vice-chancellor of the University of London, for the year 1904–5.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE.

THE program has now been issued of the congress to be held as part of the Louisiana Purchase Exposition from September 19 to 25 of the present year. The purpose and plan of the congress are thus described:

The idea of the congress grows out of the thought that the subdivision and multiplication of specialties in science has reached a stage at which investigators and scholars may derive both inspiration and profit from a general survey of the various fields of learning, planned with a view of bringing the scattered sciences into closer mutual relations. The central purpose is the unification of knowledge, an effort toward which seems appropriate on an occasion when the nations bring together an exhibit of their arts and industries. An assemblage is, therefore, to be convened at which leading representatives of theoretical and applied sciences shall set forth those general principles and fundamental conceptions which connect groups of sciences, review the historical development of special sciences, show their mutual relations and discuss their present problems.

The speakers to treat the various themes are selected in advance from the European and American continents. The discussions will be arranged on the following general plan:

After the opening of the congress on Monday afternoon, September 19, will follow, on Tuesday forenoon, addresses on main divisions of science and its applications, the general theme being the unification of each of the fields treated. These

will be followed by two addresses on each of the twenty-four great departments of knowledge. The theme of one address in each case will be the fundamental conceptions and methods, while the other will set forth the progress during the last century. The preceding addresses will be delivered by Americans, making the work of the first two days the contribution of American scholars.

On the third day, with the opening of the sections, the international work will begin. About 128 sectional meetings will be held on the four remaining days of the congress, at each of which two papers will be read, the theme of one being suggested by the relations of the special branch treated to other branches; the other by its present problems. Three hours will be devoted to each sectional meeting, thus enabling each hearer to attend eight such meetings, if he so desires. The program is so arranged that related subjects will be treated, as far as possible, at different times. The length of the principal addresses being limited to forty-five minutes each, there will remain at least one hour for five or six brief communications in each section. The addresses in each department will be collected and published in a special volume.

It is hoped that the living influence of this meeting will be yet more important than the formal addresses, and that the scholars whose names are announced in the following program of speakers and chairmen will form only a nucleus for the gathering of thousands who feel in sympathy with the efforts to bring unity into the world of knowledge.

The organization of the congress consists of:

Director of Congresses.—Howard J. Rogers.

Administrative Board.—Nicholas Murray Butler, president of Columbia University, chairman; William R. Harper, president of the University of Chicago; R. H. Jesse, president of the University of Missouri; Henry S. Pritchett, president of the Massachusetts Institute of Technology; Herbert Putnam, librarian of Congress; Frederick J. V. Skiff, director of the Field Columbian Museum.

Officers of the Congress.—President: Simon Newcomb, retired professor U. S. N. Vice-Presidents: Hugo Münsterberg, professor of psychology in Harvard University; Albion W. Small, professor of sociology in the University of Chicago.

The speakers and chairmen in the subjects more especially covered by this journal are:

DIVISION A—NORMATIVE SCIENCE.

Speaker: Professor Josiah Royce, Harvard University.

Department 1—Philosophy.

Chairman: Professor Borden P. Bowne, Boston University. Speakers: Professor George T. Ladd, Yale University; Professor George H. Howison, University of California.

Section a, Metaphysics.—Chairman: Professor A. C. Armstrong, Wesleyan University. Speakers: Professor A. E. Taylor, McGill University, Montreal; Professor Alexander T. Ormond, Princeton University.

Section b, Philosophy of Religion.—Chairman: Professor Thomas C. Hall, Union Theological Seminary, N. Y. Speakers: Professor Otto Pfleiderer, University of Berlin; Professor Ernst Troeltsch, University of Heidelberg.

Section c, Logic.—Chairman: Professor George M. Duncan, Yale University. Speakers: Professor Wilhelm Windelband, University of Heidelberg; Professor Frederick J. E. Woodbridge, Columbia University.

Section d, Methodology of Science.—Chairman: Professor James E. Creighton, Cornell University. Speakers: Professor Wilhelm Ostwald, University of Leipzig; Professor Benno Erdmann, University of Bonn.

Section e, Ethics.—Chairman: Professor George H. Palmer, Harvard University. Speakers: Professor William R. Sorley, University of Cambridge; Professor Paul Hensel, University of Erlangen.

Section f, Æsthetics.—Chairman: Professor James H. Tufts, University of Chicago. Speakers: Mr. Henry R. Marshall, New York City; Professor Max Dessoir, University of Berlin.

Department 2—Mathematics.

Chairman: Professor Henry S. White, Northwestern University. Speakers: Professor Maxime Bôcher, Harvard University; Professor James P. Pierpont, Yale University.

Section a, Algebra and Analysis.—Chairman: Professor E. H. Moore, University of Chicago. Speakers: Professor Emile Picard, The Sorbonne, member of the Institute of France; Professor Heinrich Maschke, University of Chicago.

Section b, Geometry.—Chairman: Professor William E. Story, Clark University. Speakers: M. Gaston Darboux, perpetual secretary of the Academy of Sciences, Paris; Dr. Edward Kasner, Columbia University.

Section c, Applied Mathematics.—Chairman: Professor Arthur G. Webster, Clark University, Worcester, Mass. Speakers: Professor Ludwig Boltzmann, University of Vienna; Professor Henri Poincaré, The Sorbonne, member of the Institute of France.

DIVISION C—PHYSICAL SCIENCE.

Speaker: Professor Robert S. Woodward, Columbia University.

Department 9—Physics.

Speakers: Professor Edward L. Nichols, Cornell University; Professor Carl Barus, Brown University.

Section a, Physics of Matter.—Chairman: Professor Samuel W. Stratton, director of the National Bureau of Standards, Washington. Speakers: Professor Robert W. Wood, Johns Hopkins University; Professor Francis E. Nipher, Washington University.

Section b, Physics of Ether.—Chairman: Professor Henry S. Carhart, University of Michigan. Speakers: Professor James Dewar, Royal Institution, London; Professor DeWitt B. Brace, University of Nebraska.

Section c, Physics of the Electron.—Chairman: Professor Charles R. Cross, Institute of Technology, Boston. Speaker: Professor Ernest Rutherford, McGill University, Montreal.

Department 10—Chemistry.

Chairman: Professor James M. Crafts, Massachusetts Institute of Technology. Speakers: Professor John U. Nef, University of Chicago; Professor Frank W. Clarke, chief chemist, U. S. Geological Survey.

Section a, Inorganic Chemistry.—Chairman: Professor John W. Mallet, University of Virginia. Speaker: Professor Henri Moissan, The Sorbonne, member of the Institute of France.

Section b, Organic Chemistry.—Chairman: Professor Albert B. Prescott, University of Michigan. Speakers: Professor Rudolf Fittig, University of Strassburg; Professor William A. Noyes, National Bureau of Standards.

Section c, Physical Chemistry.—Chairman: Professor Wilder D. Bancroft, Cornell University. Speakers: Professor J. H. Van't Hoff, University of Berlin; Professor Arthur A. Noyes, Massachusetts Institute of Technology.

Section d, Physiological Chemistry.—Chairman: Professor Wilbur O. Atwater, Wesleyan University. Speakers: Professor Albrecht Kossel, University of Heidelberg; Professor Russell H. Chittenden, Yale University.

Department 11—Astronomy.

Chairman: Professor George C. Comstock, director of the observatory, Madison, Wisconsin. Speakers: Professor Edward C. Pickering, director of Harvard Observatory; Professor Lewis Boss, director of Dudley Observatory.

Section a, Astrometry.—Chairman: Professor Ormond Stone, University of Virginia. Speakers: Dr. Oskar Backlund, director of the observatory, Pulkowa, Russia; Professor J. C. Kapteyn, University of Groningen, Holland.

Section b, Astrophysics.—Chairman: Professor George E. Hale, director of the Yerkes Observatory. Speakers: Professor William W. Campbell, director of the Lick Observatory; Professor Herbert H. Turner, F.R.S., University of Oxford.

Department 12—Sciences of the Earth.

Chairman: Professor Nathaniel S. Shaler, Harvard University. Speakers: Professor William M. Davis, Harvard University; Professor Thomas C. Chamberlin, University of Chicago.

Section a, Geophysics.—Chairman: Professor Christopher W. Hall, University of Minnesota. Speakers: Professor E. Wiechert, director Geophysical Institute, Göttingen; Dr. George F. Becker, geologist, U. S. Geological Survey.

Section b, Geology.—Chairman: Professor John C. Branner, Leland Stanford, Jr., University. Speakers: Sir Archibald Geikie, K.C.B., secretary of the Royal Society; President Charles R. Van Hise, University of Wisconsin.

Section c, Paleontology.—Chairman: Professor William B. Scott, Princeton University. Speakers: Dr. A. S. Woodward, F.R.S., British Museum of Natural History, London; Professor Henry F. Osborn, Columbia University.

Section d, Petrology and Mineralogy.—Chairman: Mr. Oliver C. Farrington, Field Columbian Museum, Chicago. Speakers: Professor F. Zirkel, University of Leipzig; Professor W. C. Brogger, University of Christiania.

Section e, Physiography.—Chairman: Mr. Henry Gannett, United States Geological Survey. Speakers: Professor Albrecht Penck, University

of Vienna; Professor Israel C. Russell, University of Michigan.

Section f, Geography.—Chairman: Professor George Davidson, University of California. Speakers: Dr. Hugh R. Mill, director British Rainfall Organization, London; Professor Georg Gerland, University of Strassburg.

Section g, Oceanography.—Chairman: Rear-Admiral Charles D. Sigsbee, United States Navy. Speakers: Sir John Murray, K.C.B., F.R.S., Edinburgh; His Highness, Albert, Prince of Monaco, Monaco.

Section h, Meteorology.—Chairman: Dr. Abbott L. Rotch, Blue Hill Observatory. Speaker: Professor Svante Arrhenius, University of Stockholm, Stockholm.

Department 13—Biology.

Chairman: Professor William G. Farlow, Harvard University. Speakers: Professor Jacques Loeb, University of California; Professor John M. Coulter, University of Chicago.

Section a, Phylogeny.—Chairman: Professor T. H. Morgan, Bryn Mawr. Speakers: Professor Hugo de Vries, University of Amsterdam; Professor Charles O. Whitman, University of Chicago.

Section b, Plant Morphology.—Chairman: Professor William Trelease, Washington University, St. Louis. Speakers: Professor Frederick O. Bower, University of Glasgow; Professor Karl F. Goebel, University of Munich.

Section c, Plant Physiology.—Chairman: Professor Charles R. Barnes, University of Chicago. Speakers: Professor Julius Wiessner, University of Vienna; Professor Benjamin M. Duggar, University of Missouri.

Section d, Plant Pathology.—Chairman: Professor Charles E. Bessey, University of Nebraska. Speaker: Professor Joseph C. Arthur, Purdue University.

Section e, Ecology.—Chairman: Professor Conway MacMillan, University of Minnesota. Speakers: Professor Oskar Drude, Kön. Technische Hochschule, Dresden; Professor Charles Flahault, director of the Botanic Institute, Montpellier, France.

Section f, Bacteriology.—Chairman: Professor Harold C. Ernst, Harvard University. Speakers: Professor Edwin O. Jordan, University of Chicago; Professor Theobald Smith, Harvard University.

Section g, Animal Morphology.—Chairman: Dr. Leland O. Howard, Department of Agriculture, Washington, D. C. Speakers: Professor Charles B. Davenport, University of Chicago; Professor Alfred Giard, The Sorbonne, member of the Institute of France.

Section h, Embryology.—Chairman: Professor Simon H. Gage, Cornell University. Speakers: Professor Oskar Hertwig, University of Berlin; Professor William K. Brooks, Johns Hopkins University.

Section i, Comparative Anatomy.—Chairman: Professor James P. McMurrich, University of Michigan. Speakers: Professor Max Fürbringer, University of Heidelberg; Professor Yves Delage, The Sorbonne, member of the Institute of France.

Section j, Human Anatomy.—Chairman: Professor George A. Piersol, University of Pennsylvania. Speakers: Professor Wilhelm Waldeyer, University of Berlin; Professor H. H. Donaldson, University of Chicago.

Section k, Physiology.—Chairman: Dr. S. J. Meltzer, New York. Speakers: Professor Max Verworn, University of Göttingen; Professor William H. Howell, Johns Hopkins University.

Department 14—Anthropology.

Chairman: Professor Frederic W. Putnam, Harvard University. Speakers: Dr. W J McGee, President American Anthropological Association, Washington, D. C.; Professor Franz Boas, Columbia University.

Section a, Somatology.—Chairman: Dr. Edward C. Spitzka, New York City. Speakers: Professor L. Manouvrier, School of Anthropology, Paris; Dr. George A. Dorsey, Field Columbian Museum, Chicago.

Section b, Archeology.—Chairman: Mr. William H. Holmes, Chief of the Bureau of Ethnology, Washington, D. C. Speakers: Señor Alfred Chavero, director of the National Museum, Mexico; Professor Edouard Seler, University of Berlin.

Section c, Ethnology.—Chairman: Miss Alice C. Fletcher, President of the Washington Anthropological Society. Speakers: Professor Karl von den Steinen, University of Berlin; Professor A. C. Haddon, University of Cambridge.

DIVISION D—MENTAL SCIENCE.

Speaker: President G. Stanley Hall, Clark University, Worcester, Mass.

Department 15—Psychology.

Chairman: Professor Noah K. Davis, University of Virginia. Speakers: Professor J. Mark Baldwin, Johns Hopkins University; Professor J. McKeen Cattell, Columbia University.

Section a, General Psychology.—Chairman: Professor Charles A. Strong, Columbia University. Speakers: Professor Harald Hoeffding, University of Copenhagen; Professor James Ward, University of Cambridge, England.

Section b, Experimental Psychology.—Chairman: Professor Edward A. Pace, Catholic Uni-

versity of America. Speakers: Professor Hermann Ebbinghaus, University of Breslau; Professor Edward B. Titchener, Cornell University.

Section c, Comparative and Genetic Psychology.—Chairman: Professor Edmund C. Sanford, Clark University, Worcester, Mass. Speakers: Principal C. Lloyd Morgan, University College, Bristol; Professor Mary W. Calkins, Wellesley College.

Section d, Abnormal Psychology.—Chairman: Professor Moses Allen Starr, Columbia University. Speakers: Dr. Pierre Janet, professor at the Sorbonne, Paris; Dr. Morton Prince, Boston.

Department 16—Sociology.

Chairman: Professor Frank W. Blackmar, University of Kansas. Speakers: Professor George E. Vincent, University of Chicago; Professor Franklin H. Giddings, Columbia University.

Section a, Demography.—Chairman: Professor D. Collin Wells, Dartmouth College. Speakers: Professor Walter F. Willcox, Cornell University; Professor Harald Westergaard, University of Copenhagen.

Section b, Social Structure.—Chairman: Professor Frederick W. Moore, Vanderbilt University. Speakers: Professor Ferdinand Toennies, University of Kiel; Field Marshal Gustav Ratzenhofer, Vienna.

Section c, Social Psychology.—Chairman: Professor Charles A. Ellwood, University of Missouri. Speakers: Professor Jean G. de Tarde, Collège de France, member de l'Institut, Paris; Professor Edward A. Ross, University of Nebraska.

DIVISION E—UTILITARIAN SCIENCES.

Speaker: President David Starr Jordan, Leland Stanford, Jr., University.

Department 17—Medicine.

Chairman: Dr. William Osler, Johns Hopkins University. Speakers: Dr. William T. Councilman, Harvard University; Dr. Frank Billings, Rush Medical College.

Section a, Public Health.—Chairman: Dr. Walter Wyman, surgeon-general of the U. S. Marine Hospital Service. Speakers: Professor William T. Sedgwick, Massachusetts Institute of Technology; Dr. Ernest J. Lederle, Commissioner of Health, New York City.

Section b, Preventive Medicine.—Chairman: Dr. Joseph M. Mathews, president of the State Board of Health, Louisville, Kentucky. Speakers: Professor Ronald Ross, F.R.S., School of Tropical Medicine, University College, Liverpool; Professor Angelo Celli, University of Rome.

Section c, Pathology.—Chairman: Professor Simon Flexner, director of the Rockefeller Institute. Speakers: Professor Felix Marchand, University of Leipzig; Professor Johannes Orth, University of Berlin.

Section d, Therapeutics and Pharmacology.—Chairman: Dr. Hobart A. Hare, Jefferson Medical College. Speakers: Sir Lauder Brunton, F.R.S., London; Professor Mathias E. O. Liebreich, University of Berlin.

Section e, Internal Medicine.—Chairman: Professor Frederick C. Shattuck, Harvard University. Speakers: Professor Clifford Allbutt, F.R.S., University of Cambridge; Professor William S. Thayer, Johns Hopkins University.

Section f, Neurology.—Chairman: Professor Lewellys F. Barker, University of Chicago. Speakers: Professor Shibasaburo Kitasato, University of Tokio; Professor James J. Putnam, Harvard University.

Section g, Psychiatry.—Chairman: Dr. Edward Cowles, Boston. Speakers: Professor Th. Ziehen, University of Berlin; Dr. Charles L. Dana, New York City.

Section h, Surgery.—Chairman: Professor Carl Beck, Post Graduate Medical School, New York. Speaker: Professor Nicholas Senn, Rush Medical College, Chicago.

Section i, Gynecology.—Chairman: Professor Howard A. Kelly, Johns Hopkins University. Speakers: Dr. L. Gustave Richelot, member of the Academy of Medicine, Paris; Professor John C. Webster, Rush Medical College, Chicago.

Section j, Ophthalmology.—Chairman: Dr. George C. Harlan, Philadelphia, Pa. Speaker: Dr. Edward Jackson, Denver, Col.

Section k, Otology and Laryngology.—Chairman: Professor William C. Glasgow, Washington University, St. Louis. Speakers: Sir Felix Semon, C.V.O., physician extraordinary to the king, London; Dr. J. Solis-Cohen, Jefferson Medical College.

Section l, Pediatrics.—Chairman: Professor Thomas M. Rotch, Harvard University. Speakers: Professor Theodore Escherich, University of Vienna; Professor Abraham Jacobi, Columbia University.

Department 18—Technology.

Chairman: Chancellor Winfield S. Chaplin, Washington University, St. Louis. Speakers: Professor Henry T. Bovey, F.R.S., McGill University, Montreal; Mr. John R. Freeman, Providence, R. I.

Section a, Civil Engineering.—Chairman: Professor William H. Burr, Columbia University. Speakers: Dr. J. A. L. Waddell, consulting engineer, Kansas City; Mr. Lewis M. Haupt, consulting engineer, Philadelphia.

Section b, Mechanical Engineering.—Chairman: President Alexander C. Humphreys, Stevens Institute of Technology. Speakers: Professor A. Riedler, Königliche Technische Hochschule, Berlin; Professor Albert W. Smith, Leland Stanford, Jr., University.

Section c, Electrical Engineering.—Chairman: Professor Arthur E. Kennelly, Harvard University. Speakers: Signor G. Marconi, Italy; Professor Michael I. Pupin, Columbia University.

Section d, Mining Engineering.—Chairman: Mr. John Hays Hammond, New York City. Speakers: Professor Robert H. Richards, Massachusetts Institute of Technology; Professor Samuel B. Christy, University of California.

Section e, Technical Chemistry.—Chairman: Professor Charles F. Chandler, Columbia University. Speakers: Professor Otto N. Witt, Königliche Technische Hochschule, Berlin; Professor William H. Walker, Massachusetts Institute of Technology.

Section f, Agriculture.—Chairman: Honorable James Wilson, Secretary of Agriculture, Washington. Speakers: Professor Léon Lindet, National Agronomic Institute, Paris; Professor Liberty H. Bailey, Cornell University.

THE THIRTIETH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY.

THE thirtieth general meeting of the American Chemical Society was held in Providence, R. I., during Tuesday, Wednesday and Thursday, June 21–23, the place of meeting being Rockefeller Hall, on the campus of Brown University. At the opening session President Wm. H. P. Faunce, of the university, delivered an address of welcome, and this was followed by a response on behalf of the society by its president, Professor A. A. Noyes. The members of the local section gave themselves without reserve to providing for the comfort of the visitors, and their hospitality received full appreciation. Luncheons were served in Sayles Memorial Hall on Tuesday and Wednesday by the courtesy of two local companies, T. P. Shepard & Co., and the Rumford Chemical Works. The University Club extended its house privileges to all members of the society during the entire meeting, and on Tuesday evening entertained them at a most enjoyable informal reception. On Thursday afternoon, the members of the local section invited the visitors to attend a Rhode Island clambake at the Pomham Club, on the shore of Narragansett Bay. This 'crowning event' of the meeting was closed by a series of impromptu speeches, when Professor J. H. Appleton, the chairman of the local committee, proved himself a very entertaining toastmaster.

In addition to the regular morning sessions, an open lecture was delivered on Wednesday evening by Dr. H. W. Wiley, of Washington. This was the first public announcement of the results obtained in his important series of experiments upon the effect of the food preservatives, boric acid and borax, on metabolism. A summary of these results appeared in all the leading newspapers in the issue of June 23.

At the close of the last session a hearty vote of thanks was extended to Professor Appleton and his associates and to the various local organizations by whom courtesies were shown to the visiting members. The list of manufacturing concerns that opened their doors to the various afternoon excursion parties is too numerous to be included here.

The number of members in attendance was 128, of whom 104 were visitors. The next meeting will be held in Philadelphia, beginning December 27.

REPORTS FROM INSTITUTIONS.

A new feature was the presentation of reports from various institutions upon the research work which has been in progress during the past year. Lack of space forbids the reprinting of these reports in full, and the following brief summaries, which may serve to give a general idea of the progress of such work, are by no means exhaustive. It should also be said, in justice to those who presented the reports, that

some were made impromptu, in response to special request.

Harvard University.—Aromatic addition products, especially new derivatives of tetrabromorthoquinone. Detection and estimation of small quantities of arsenic and antimony in toxicological work. Dissociation of certain addition products, as phenoquinone, in benzene solution. Atomic weights of iodine, cadmium, sodium, etc. Decomposition of silver oxide above 300°. Conductivity of potassium iodide in melted iodine. Energy changes of iron and nickel. Study of amalgam cells. Study of specific heats of liquids by a new method. Continuations of certain former investigations.

Columbia University.—Various researches in physiological chemistry, some of which have already been published. Organic: On *m*-aminobenzonitrile. Extension of synthetic methods for the preparation of quinazolines. Physical: combination of a solvent with the ions. Dissociation of lead nitrate. Thermo-chemistry of electrolytic dissociation. Ionic equilibrium of solutions of potassium silver cyanide, etc. Industrial: Electrical preparation of metallic magnesium. Extraction of radioactive bodies from carnotite. Analytical: Reduction of lead from litharge in preliminary assays. A crucible charge for gold and silver in zinc ores. Determination of molybdenum in steel, etc. Separation of thorium from cerium, etc. Determination of nitrogen in organic compounds. Determination of formaldehyde.

Massachusetts Institute of Technology.—Physical Chemistry: Dissociation at high temperatures. Conductivity of fused electrolytes; also of very dilute solutions. Test of a method for determining absolute potential. Reaction between potassium sulphocyanate and mercuric sulphocyanate. Hydrolysis of ammonium sulphide. Dissociation relations of sulphuric acid as determined by comparative inverting power, etc. Industrial: Commercial preparation of chloroform from acetylene. Purification of low-grade rosins. Bleaching with sodium hypochlorite. Hydrocarbons in distilled wool grease. Organic: Systematic identification of nitrogen compounds. Experiments with a view to preparing a bivalent carbon compound.

University of California.—Gravimetric determination of free acids. Investigation of California petroleum, and also of tar from oil distillation. Action of nitrogen on various oxides in presence of carbon. Solubility of salts of boric acid in presence of salts of other acids. New method of extraction from sulphide ores. On the existence of ethers of fulminic acid. Chemical reactions of the cyanide process. Coprecipitation of gold and platinum with silver chloride. Constitution of *p*-nitroso compounds. Synthesis of acetylene derivatives.

Yale University.—Kent Laboratory: In addition to eleven papers already published, there are sixteen investigations, some of which are completed but not yet reported upon, while others are still in progress. Sheffield Laboratory: Work on double and triple salts. Heat of combustion of carbon from acetylene. Pyrimidine derivatives. Thiocyanates and isothiocyanates. Triazoles. Laboratory of Physiological Chemistry: Study of certain aspects of nutrition. Paths of excretion for inorganic compounds. Physiological chemistry of the compounds. Physiological chemistry of the invertebrates. Utilization of proteids.

University of Chicago.—Dissociation phenomena in the glycol and glycerin series. Relations between the forms of sulphur. Velocity of saponification of imido ethers. Stereoisomeric chlorimido derivatives and the Beckmann rearrangement. Constitution of purpuric acid.

Preparation of homologous alkyl isoureas. Ionization constants of phenolphthalein, and its use as an indicator. Relation of radium to uranium.

Johns Hopkins University.—Phenylsulphone-orthocarboxylic acid. Effect on zinc of dry hydrochloric acid dissolved in benzene. Clay mixtures and the burning of porous cells. Preparation of cells for osmotic pressure work. Electric combustion furnace. Depression of the freezing point in concentrated aqueous solutions. Conductivity of electrolytes in mixtures of alcohol and water. Decomposition products of sodamide; also its reactions with phosphorus pentachloride and with yellow phosphorus. Temperature coefficients of conductivity from 40° to — 40°. Decompositions of nitroso compounds. A step toward the synthesis of camphoric acid.

University of Wisconsin.—Influence of chemical reaction upon weight. Coloring matters of plants. Soap solutions. Phenoxozone compounds (effect of substitution on the ease of formation of condensation products). Effect of oxidizing agents upon the solubility of gold in various reagents. Formation of alkaline and silver tellurates, of chromium ammonium peroxides, etc. Atomic weight of selenium. Osmosis with solvents other than water and with various membranes.

Leland Stanford University.—Purification of feed waters, especially in arid regions. Spectroscopic study of some rare elements. Methyl amine as a solvent. Reactions in ammonia. Hydrochloric acid addition products of stannous chloride. Modification of freezing-point method for molecular weight determinations. Metastability in the case of sodium thiosulphate; also solubilities of the different forms.

University of North Carolina.—Investigations on thorium and certain of the rare earths; carolinium. Radio-active constituents of monazite sands. Action of radium emanations on minerals. New organic salts of neodymium. Strontium malate. The methoxy group in certain lignocelluloses. Action of bromine on trichlorethylidene diparanitrophenamine.

Verbal reports were also made by Professor Bancroft, representing Cornell University, and Professor Johnson, representing the University of Michigan.

PAPERS.

The following papers were read before the society:

The Ratio of Radium to Uranium in Minerals: Bertram B. Boltwood.

The investigation of a series of nine uranium minerals has led to the conclusion that the amount of radium present in any given mineral is proportional to the uranium content. This would seem to offer strong evidence of the truth of Rutherford's suggestion that radium is formed by the decomposition of uranium. The method employed for the quantitative determination of the radium depends on the measurement of the maximum or equilibrium quantity of emanation formed from the radium salts present.

The Qualitative Separation and Detection of the Group of Elements whose Oxides are Insoluble in Nitric Acid: Arthur A. Noyes.

An account of this work, which is not yet in final form, will be published later in the year.

Note on the Amount of Moisture which Phosphorus Pentoxide Leaves in a Gas: Edward W. Morley.

The author formerly found that the sum of the moisture left, and the phosphorus pentoxide absorbed, in a gas, is not more than a milligram in 45,000 liters. He now finds the phosphorus pentoxide alone to be one milligram in 45,000 liters. To the degree of approximation so far attained,

therefore, it seems that the moisture left in a gas by phosphorus pentoxide is *nil*. A gas may be made as dry as the figures indicate, by passing at the rate of two liters an hour *through* 25 c.c. of phosphorus pentoxide. The difficulty often experienced in filling a glass apparatus with a perfectly dry gas is due to the wetting of the dried gas by the water persistently adhering to the surface of the glass.

Bromides of Ruthenium: JAS. LEWIS HOWE.

These compounds were prepared by the action of hydrobromic acid upon ruthenium tetroxide. Addition of alkali bromides gives brom-ruthenites of the formula $X_2'RuBr_5$, which, when boiled with dilute alcohol acidified with hydrobromic acid, give aqua brom-ruthenates, $X_2'Ru(H_2O)Br_5$. The latter form, on addition of bromine, the salts $X_2'RuBr_6$. All of these salts are analogous and similar to the corresponding chlorides.

Changes in the Composition of the Ferrocyanides of Cadmium, Zinc and Manganese after Precipitation: E. H. MILLER and M. J. FALK.

Several new double ferrocyanides of cadmium, ammonium and potassium were described. The investigation also showed that the precipitate formed in the ordinary titration of zinc in the presence of ammonium chloride is an ammonium potassium zinc ferrocyanide, and not $K_2Zn_3Fe(CN)_6$ as given heretofore.

Silica Determinations: HARRISON EVERETT ASHLEY.

The Atomic Weight of Beryllium: C. L. PARSONS.

An abstract of this paper has recently appeared in SCIENCE in a report of a meeting of the New York section (p. 923).

The 'Drop' Method for Surface Tension as a Means for Ascertaining the Molecular Weight in the Liquid State: J. LIVINGSTON R. MORGAN. (By title.)

The Constitution of the Brasses: WILDER D. BANCROFT.

Six sets of solid solutions crystallize from molten mixtures of copper and zinc. Below 400° only five of these are stable. The α crystals (100–63 per cent. copper at 400°) are yellow, the β crystals (54–51 per cent. copper) are reddish, while the other four series are silvery. Brasses containing 51–40 per cent. copper consist of a mixture of brittle silvery crystals and ductile reddish-yellow crystals. An alloy containing 43 per cent. of copper was shown in which the fracture was silvery, while the polished surface was yellow.

The Transport Number of Sulphuric Acid: O. F. TOWER.

Experiments were made with normal, one half normal, one fifth normal, one tenth normal, one twentieth normal and one fiftieth normal acid and at the temperatures 8°, 20° and 32°.

It was found that the transport number decreases with the concentration and is practically constant at the concentrations one twentieth and one fiftieth normal. The average value found at these concentrations was 0.180 at 20°. At other temperatures between 8° and 32° the following equation holds:

$$n_t = 0.18° + 0.0011(t - 20°).$$

The Hydration of Milk Sugar in Solution: C. S. HUDSON.

By determinations of the initial and final solubility of solid milk sugar hydrate and milk sugar anhydride, conclusions are drawn as to the state of hydration of milk sugar molecules in solution. The change in the hydration proceeds so slowly as to be accurately followed, and the results obtained by other methods are in entire agreement.

Migration of Colloids: W. R. WHITNEY and J. C. BLAKE. (By title.)

The Vapor Pressure of Sulphur at 100° C.: HIPPOLYTE GRUENER.

These determinations, in which carbon dioxide was passed over solid sulphur, resulted as follows:

With prismatic sulphur .... 0.007 mm.
With rhombic sulphur ..... 0.0065 mm.

Although this value is so small, considerable amounts of sulphur pass over when water containing it in suspension is boiled.

Some Notes on Laurent Polariscope Readings: GEO. W. ROLFE and CHAS. FIELD, 3d.

These rotation readings are about 0.2 per cent. lower than those given by the Lippich apparatus. The experiments of the authors indicate that this variation is not due to the imperfections of the polariscope, as asserted by some, but to the nature of the light used.

The Molecular Depression Constant of p-Azoxyanisol: H. MONMOUTH SMITH.

This value has been determined at different times and stated variously to be 750, 654 and 545. A redetermination of this constant was made and a value of 563 obtained. Ketones were found to give an abnormal value 32 per cent. higher than the average found from other classes of compounds.

The Sulphates of Beryllium: C. L. PARSONS.

Of those described, namely, $BeSO_4 \cdot 4H_2O$, $BeSO_4 \cdot 2H_2O$, $BeSO_4 \cdot 7H_2O$, $BeSO_4$, and certain basic sulphates, the first is comparatively stable in moist air, and the second in dry air. There is good evidence that the third does not exist, and the fourth could not be prepared by any methods used by the author. The basic sulphates are probably only solid solutions.

Turpentine and Colophonium of the Northern Pine and Douglas Fir: G. B. FRANKFORTER. (By title.)

Metallic and Other Salts of Eugenol: G. B. FRANKFORTER. (By title.)

The Wurtz Synthesis: JAMES F. NORRIS. (By title.)

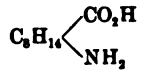
Strontium Malate: ALVIN S. WHEELER and W. MCKIM MARRIOTTE. (By title.)

The Oxidation of Phenylnaphthalenedicarboxylic Acid: JOHN E. BUCHER.

The principal products obtained were diphenyltetracarboxylic acid, two isomeric oxal-diphenyltricarboxylic acids, and a very small quantity of *o*-benzoylbenzoic acid. In addition to these, a number of other acids were found whose constitution has not yet been determined.

The Decomposition of Nitroso Compounds: WILLIAM A. NOYES and R. DE M. TAVEAU.

From the compound



four decomposition products have previously been described by one of the authors. By treatment of the nitroso derivative of the anhydride of this acid with sodium hydroxide and methyl or ethyl alcohol they have now obtained addition products of formaldehyde and acetaldehyde, respectively, with the nitroso compound less the nitroso group. The investigation will be extended to other nitroso compounds.

Substitution in the Aliphatic Series: A. MICHAEL and H. J. TURNER.

When bromine is forced to act upon propane, the effect is confined to the methylene group, while chlorine, which has more free energy, acts not only upon the methylene but also to a smaller extent upon the less susceptible methyl group. An analogous effect is observed in the case of hexane. Each halogen produces more of the secondary substitution product than of the tertiary, but the ratio of their amounts is 4:1 with bromine, and 3:2 with chlorine. Chlorine also yields a larger quantity of primary hexyl chloride than does bromine.

The Effect of Constitutive Influences upon the Additive Power of Carbonyl: A. MICHAEL and H. J. TURNER.

This was studied by observing the stability of the semicarbazones in the presence

of acids of different strengths. The additive power of methyl butyl ketone is greater than that of acetaldehyde; of substituted acetoacetic ester, less than that of the ester.

The Carbon from Acetylene, the Fourth Allotropic Form of Carbon. WILLIAM G. MIXTER. (By title.)

Some Experiments on the Fuel Value of Coal Ashes. HENRY FAY. (By title.)

Bleaching of Flour. EDWARD GUDEMAN. (By title.)

The Action of Water and Salt Solutions upon Certain Slightly Soluble Phosphates: F. K. CAMERON and L. A. HURST.

The hydrolysis was shown to be relatively great, and to depend upon the proportion of solid in contact with the solution. The effect of alkalies and acids was to increase the amount of phosphoric acid dissolved from iron or aluminum phosphate, but the effect of neutral salts could not be predicated.

The Action of Water and Some Solutions on the Phosphates of Calcium: J. K. CAMERON and ATHERTON SEIDELL.

Owing to the similarity between results obtained with iron and aluminum phosphates on one hand and tricalcium phosphate on the other, it was deemed advisable to study also mono- and dicalcium phosphates, which can be obtained as definite and well characterized solids. Monocalcium and tricalcium phosphates are greatly decomposed by water, while dicalcium phosphate is but slightly decomposed and is the stable form under ordinary conditions.

The Solubility of Calcium Sulphate in Solutions of Nitrates: ATHERTON SEIDELL and J. G. SMITH.

Experiments were made with the nitrates of magnesium, calcium, sodium and potassium, the character of the phenomena differing in each case.

The Disinfection of Public Water Supplies: GEORGE A. SOPER. (By title.)

Relation of Chemical Disinfectants to Hygiene and Sanitation: WM. DREYFUS. (By title.)

The Determination of Ammonia in Milk: H. C. SHERMAN and W. N. BERG.

The method described is an adaptation of the Boussingault vacuum distillation as modified by Shaffer for the determination of ammonia in urine. The results obtained in the examination of fresh milk are believed to be accurate within a variation of $\pm$ 0.0003 per cent. and furnish a very delicate means of following certain types of fermentation. The method is being employed in a study of the amounts and significance of ammonia in cows' milk.

The Variations in Standard among Ventzke Saccharimeters: HARRIS E. SAWYER.

Examination of sixteen quartz-wedge saccharimeters,—fourteen being Schmidt and Haensch instruments,—has shown that there seem to be two standards of adjustment among polariscopes of this class.

Five instruments were found which evidently are intended to read 100°, on a 200 mm. column of sucrose solution, prepared and polarized at 17½° C. and containing 26.048 grams of sugar in 100 Mohr c.c. The other eleven instruments were as obviously graduated to read 100° on a solution of the same normal weight, at the same temperature, in 100 true c.c.

The comparison of these instruments was made by the use both of quartz plates and of standard solutions of sugar.

The Colorimetric Estimation of Magnesium: OSWALD SCHREINER and W. S. FERRIS.

Magnesium precipitated with K_2HPO_4, then washed with three per cent. ammonia solution, dissolved in aqueous nitric acid and treated with ammonium molybdate, gives a color suitable for comparison against standard solutions prepared from sodium phosphate. Results were given

showing an agreement of about 0.5 part per million.

The Colorimetric Estimation of Phosphates; Second Method: OSWALD SCHREINER and B. E. BROWN.

The first method previously described requires the precipitation of the phosphorus as the well known yellow molybdate containing phosphorus and ammonia. In this second method the phosphorus is precipitated with magnesia solution, washed with ammonia, dissolved in nitric acid, and read in the colorimeter after addition of molybdate.

Determination of Sulphur and Phosphorus in Food, Fæces and Urine: J. A. LE CLERC and W. L. DUBOIS. (By title.)

Device for Reading 'Nesslerized' Ammonia Tubes in Water Analysis: W. P. MASON. (By title.)

A Peculiar Occurrence of Bitumen and Evidence as to its Origin: WILLIAM CONGER MORGAN. (By title.)

AUSTIN M. PATTERSON.

MATERIAL VERSUS INTELLECTUAL DEVELOPMENT OF OUR UNIVERSITIES.

THE material development of our universities within the past two decades may safely be characterized as phenomenal, and has been more than commensurate with that of the country at large.

As a result the plain inexpensive college buildings of the past now stand by the side of palaces of to-day, while stately gateways and imposing walls flank the carefully graded grounds that once constituted the relatively unkempt campus.

Public taste is being awakened and directed to an appreciation of the beautiful. But apart from the esthetic side the equipment of scientific laboratories and the development of college libraries and museums have been distinguishing features in the recent growth of our institutions of higher learning.

The surroundings of the student are now far more hygienic than in the past, and things once regarded as luxuries are now rightly considered necessities of life. As an evidence of this we need only quote the following from a recent annual report of the president of Harvard University: "The practise of fifty years ago at Harvard College in respect to ventilation would now be against the law, * * * and public opinion would not now endorse the complete absence of bath-rooms from the dormitories owned by the college, an absence which occasioned very little remark down to the year 1890."

But lest we praise too unstintingly this unparalleled progress of the past twenty years, we should seriously consider whether the intellectual welfare of our universities is developing in even measure with their material progress.

The beauty of college grounds and stately buildings can not of itself elevate public taste, nor can extensively equipped laboratories turn out great workers in the fields of science. Too often, indeed, these things stultify through the very sense of satisfaction they engender in our minds. A wooden shed at Penikese was a sufficient opportunity for an Agassiz, and the dull routine of a colliery was but an incentive to the inventive mind of a Stephenson.

The age demands strong men and we must learn to respect our colleges not for their wealth in material things, but for having been the cradle and the home of leaders of thought and action.

A study of the reports of the commissioner of education and of announcements of college presidents and other officers may throw some interesting light upon certain phases of the intellectual and material progress of our colleges. Certain features, such as the increase in the number of students, the growth of libraries, the increase in the faculties and the development of the

post-graduate schools, may, if taken together and closely analyzed, be considered to provide a fair index of the intellectual growth of our colleges.

On the other hand, the increase in total value of the property, the increase in endowment funds, annual cost of buildings and the amounts of benefactions and appropriations for college buildings and grounds may contribute more or less directly to intellectual growth, but are not necessarily indicative of such development.

The fact is that the material progress of our colleges has in the past twenty years outstripped the *intellectual,* and while they have unquestionably grown as centers of learning, growth in *material* wealth has been the great distinguishing feature of their progress.

For example, we find that in the year 1902 there were 1.53 times as many colleges and universities in the United States as there were in 1890. During the same period, however, the number of students increased 1.9 times, or in even greater ratio than the number of colleges. This certainly is indicative of a growing desire, or a better ability, to take advantage of a college education, and yet the total number of students in 1902 was but 107,391, or less than one seven-hundredth of our population.

The student of 1902 found twice as many teachers in the colleges as compared with his predecessor of 1890, but as the number of students had also doubled, the classes under each teacher were on the average as large as were those of 1890. It appears that our colleges, as a whole, have not been able to increase the teaching force in greater ratio than the growth of the student body, although it has long been recognized that small classes, or divisions, are necessary in order to secure the paramount advantage to the student of a close personal relation with his teacher.

Our most progressive universities have, however, striven earnestly to attain this end, but have been able to achieve it only by appointing a large number of young instructors and assistants at small salaries. Indeed, the average salary paid to members of the faculty in our leading eastern universities has declined steadily. At the same time the percentage of instructors, assistants and other subordinates serving upon the teaching force has risen.

In other words, the teaching is now performed more largely by young and poorly paid men. Albeit, however, young as they be, they are men the average of whose ability is high.

The case of two of our greatest eastern universities is typical of the general situation: In one of these in 1889–90, 39 per cent. of the teaching force were professors or assistant professors, and the average salary was $1,500; in 1892–03, however, the number of professors and assistant professors had decreased to 28 per cent. of the total number of teachers, while the average salary had declined to $1,257.

In another great institution in the New England states, 49 per cent. of the teachers were professors or assistant professors in 1890, and the average salary was $1,454; while in 1902–03, only 37 per cent. of the faculty were professors and the average salary was about $1,355.

Promotion within the faculty of these great institutions has become so slow that it may be not inaptly compared with this condition within the United States Navy between the years 1868–98, when gray-haired lieutenants were the rule. The years of struggle have been lengthened for the aspirant to collegiate position, and college teachers of marked ability are now ordinarily men of middle age before being promoted to an assistant professorship.

This condition of affairs can not fail but to react unfavorably upon the universities

themselves, for the best young men of our land must realize all too fully that effort and ability sufficient to win high honor in the professions, or in business affairs, will avail but little if exerted within the college walls, and that for many years they and their families must live upon less than is earned by railway conductors, or baggage inspectors in the custom house.

It is, indeed, an open question at the present day whether the members of our greatest faculties compare favorably in judgment, or even in character, with leaders in law, medicine or affairs. Too often one feels that the narrowing influence produced by years of poverty has had its final effect upon the minds of many of our best scholars. Unless conditions be changed the faculties of our universities must surely deteriorate, and the cause of education will suffer incomparably; and is now suffering to a greater degree than even the intelligent public realize.

A certain lack of public respect for our great scholars is another but closely related factor that operates against the true interests of education. The names of Whitney, Gray, Leidy and Peirce have an unfamiliar sound to us in comparison with those of Max Müller, Sir Joseph Hooker, Sir Richard Owen and Sir George Airy, their foreign contemporaries of no greater worth.

It is true that the hope of being able to advance the good of the world should be a sufficient incentive to our effort; but men are not abstractions of philosophy, and grievously underpaid and unhonored professions will fail to enlist the interest of our ablest youth.

But to consider another phase of the intellectual growth of our colleges; one of the most recent as well as the most hopeful is the development of post-graduate schools by all of our leading universities. It is here, and here only, that advanced and productive scholarship appears among the student body. The love and ambition for research is fostered here, and comparison between our universities and those of Germany can only be instituted with reference to our post-graduate schools, for only in this direction of progress do we approach the German standard.

Yet in 1902–03 the graduate students were but 4.6 per cent. of our student body, and if the graduate schools increase at the rate at which they have developed since 1890, more than a century must elapse before one half of the students in our universities will be in the graduate school. No great progress can be expected until the colleges can afford to appoint leaders of thought to professorships, the duties of which shall be confined to the graduate school. It seems, indeed, remarkable that this has not been done, for we have long since recognized that a primary condition of successful management demands that special faculties shall preside over the affairs of our medical, law, technical and other schools under the auspices of universities. Why should our graduate schools be without a special faculty? The work of the graduate school centers upon research, and it is, indeed, significant that the greatest encouragement ever given to research in pure science has come not from our colleges, but from one whose unparalleled success was achieved through the practical application of principles of science to industrial effort.

There is yet another standard by which we may measure the intellectual growth of our colleges. Their libraries in 1902 contained 2.1 times as many volumes as in 1890. Public libraries not connected with colleges, however, achieved the same increase in the same interval.

We now approach the consideration of the growth of our colleges in material things between 1889–90 and 1902, and the

TABLE SHOWING THE MATERIAL AND THE 'INTELLECTUAL' RESOURCES OF UNIVERSITIES AND COLLEGES OF THE UNITED STATES IN 1902; AND THEIR INCREASE SINCE 1889–1890.

Material Resources, 1902.	Amount.	Ratio of Increase Since 1889–'90.	'Intellectual' Status, 1902.	Total Number.	Ratio of Increase Since 1889–'90.
Total value of property.	$417,205,234	2.83	Number of universities and colleges.	638	1.53
Value of grounds and buildings.	154,529,288	2.4	Number of students.	107,391	1.9
Endowment funds.	185,944,668	2.5	Post-graduate students.	4,942	2.47
Benefactions received during the year 1902.	17,039,967	2.8	Number of teachers.	15,945	2
Appropriation received from states, cities, etc.	6,437,493	4.5	Number of books and libraries.	8,784,307	2.1
Cost of buildings erected during the year 1902.	5,680,000 at least	2.8 at least			
Income exclusive of benefactions.	33,863,244	3.3			

result of our studies may be summarized in the accompanying table.

Inspection of this table will reveal the fact that in the interval between 1889–90 and 1902 the material resources of our colleges have become from 2.4 to 4.5 times as great as at the beginning of this period, while their 'intellectual' resources, measured by the increase in schools, students, teachers and books, have become only from 1.53 to 2.47 times as great as in 1890.

The progress of our colleges in the past twelve years has been material rather than intellectual.

It is not the purpose of this article altogether to decry this progress, for many conditions have rendered it for the time, at least, desirable or even necessary, but it must be checked erelong and the *intellectual* side, the soul of the college, developed in greater ratio.

College presidents and boards of trustees must realize that imposing buildings and expensively equipped laboratories will not make universities. I grant that in our country it is usually far easier to gather funds for the erection of buildings than for the development of unseen things, but this fact alone should be a stimulus to those to whom the destiny of our colleges is entrusted to seek even more ardently for aid in the adequate endowment of professorships, for funds required in the prosecution and publication of research, for the enlargement of learned libraries, and for all things pertaining to the intellectual life of the college. Men who give of their wealth to aid our colleges are usually actuated by unselfish motives, and would gratefully receive the advice of those in control of the destiny of education, to advance the highest even if unseen, rather than to create the spectacular and superficial.

ALFRED GOLDSBOROUGH MAYER.
MARINE BIOLOGICAL LABORATORY,
TORTUGAS, FLA.

SCIENTIFIC BOOKS.

The Vegetable Alkaloids. With particular reference to their chemical constitution. By Dr. AMÉ PICTET, Professor in the University of Geneva. From the second French edition. Rendered into English, revised and enlarged, with the author's sanction, by H. C. BIDDLE, Ph.D., Instructor in the University of California. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1904. 8vo. Pp. vii + 505. Cloth, $5.00.

The publication of the classical work on 'Die Pflanzenstoffe' by Dr. August Huse-

mann, in 1871, marked the beginning of monographic work on proximate plant constituents. This work was revised in 1882, but no subsequent revisions have been made, and no other work has been published to take its place, doubtless owing to the great labor involved in collaborating the extensive researches of the past twenty-five years. Even 'Die Rohstoffe des Pflanzenreiches' by Wiesner, the second edition of which appeared not long ago (1902), required the assistance of a dozen collaborators. In more recent years the tendency has been for authors to confine their attention to single groups of plant constituents, as for example, the study of the carbohydrates by Tollens; the ethereal oils, by Gildemeister and Hoffmann, etc. One of the earliest of these works was that of Pictet on the 'Chemical Constitution of the Vegetable Alkaloids,' and the present work by Dr. Biddle is not only an English translation, but a revision of Pictet's work.

It is almost a hundred years since Sertürner, an apothecary of Hanover, isolated the first basic organic substance, or alkaloid. He obtained from opium a body termed by him *morphium*, which he compared to ammonia. This subject, however, did not arouse any special interest until about 1817, and during the next twenty years a number of the most important vegetable alkaloids were discovered, including emetine, strychnine, caffeine, quinine, nicotine, conine, atropine, aconitine, etc. The complex nature of these alkaloids rendered their study difficult, until Liebig showed that they are merely ammonia bases in which a hydrogen atom is replaced by an organic radical. This view was later confirmed by the classical researches of Wurtz and Hofmann, which led, nearly fifty years after Sertürner's isolation of morphine, to the first synthesis of an organic base, viz., conine, by Ladenburg.

It was found that most of the vegetable alkaloids are derivatives of pyridine, a compound discovered by Anderson in 'Dippel's oil,' a product obtained by the dry distillation of bones. Not all the alkaloids, however, are related to pyridine, some, as caffeine and theobromine, being uric acid derivatives, as pointed out by E. Fischer, in 1883. Betaine, muscarine and some others are closely related to the amines of the fatty acids, while still others, as leucine and glutamine, belong to the asparagine group.

The fact that most of the alkaloids were found to be in the nature of pyridine bases led to the study of the constitution of these bases as found in coal tar. Under the leadership of Hofmann research in this particular field was followed with a great deal of enthusiasm, and to him belongs the credit of first establishing the constitution of an alkaloid, viz., conine, the chief alkaloid of poison hemlock, which later was prepared, as already stated, synthetically by Ladenburg.

At the present, not only on account of the scientific interest of the subject, but also because of the economic value of these products, a large number of investigators are devoting attention to the study of the chemistry of the alkaloids. The result is a voluminous literature, and it is fortunate for not only students of chemistry and phyto-chemistry, but others as well, that these results have been brought together in the volume at hand. The work is divided into two parts, the first dealing with the artificial bases closely related to the natural alkaloids, and the second with the chemical behavior of the alkaloids and the bearing of this on their chemical constitution. The book has been brought up to date in most instances, as seen by the incorporation of the brilliant investigations of Ladenburg, Merling and Willstätter on the synthesis of atropine, atropamine, belladonnine, inactive cocaine and tropacocaine; the recent investigations of Von Gerichten and Knorr on morphine and codeine; the studies of Gadamer as well as Dobbie and Lauder on corydaline; Willstätter and Fourneau's work on lupinine; Rauwerda's work on cytisine; and also the extensive studies on the alkaloids of jaborandi, tobacco, coffee, etc., by Jowett, Pinner, Pictet, Fischer and various other investigators. There are, however, a number of recent investigations, the results of which are not included, but which would enhance a work of this kind, as

that of Miller on the constitution of ephedrine; the researches of Paul and Cownley on the alkaloids of ipecac; and those of Fischer, Schlotterbeck and others on various alkaloids, which have been published in the past few years in the *Proceedings of the American Pharmaceutical Association*. The physiological properties given in connection with some of the alkaloids might well be omitted in a work of this kind, particularly as a few of them are not entirely accurate. The index would be more helpful if the plant names were included in all cases, in addition to the names of the alkaloids derived from them. An enlargement on the parts dealing with physical properties and important chemical tests would add to the value of the book and make it appreciated by a larger number.

HENRY KRAEMER.

SCIENTIFIC JOURNALS AND ARTICLES.

THE June number (volume 10, number 9) of the *Bulletin of the American Mathematical Society* contains: Report of the April Meeting of the Chicago Section of the Society, by T. F. Holgate; 'The Heine-Borel Theorem,' by Oswald Veblen; 'On Self-Dual Scrolls,' by C. H. Sisam; 'On Some Tendencies in Geometric Investigations,' by Corrado Segre; Reply to Professor Snyder's Review of Study's Geometrie der Dynamen, by Eduard Study, with Note by Virgil Snyder; 'Notes'; 'New Publications.'

The July number of the *Bulletin* contains: Report of the April Meeting of the Society, by F. N. Cole; Report of the April Meeting of the San Francisco Section, by G. A. Miller; 'On Linear Homogeneous Difference Equations and Continuous Groups,' by Saul Epsteen; Review of Warren's Experimental and Theoretical Course of Geometry, by R. E. Moritz; a number of 'Shorter Notices'; 'Notes'; 'New Publications'; 'Thirteenth Annual List of Published Papers'; Index of Volume 10.

A general index of the *Bulletin*, from 1891 to 1904, is in preparation.

The American Journal of Science for July contains the following articles:

H. A. BUMSTEAD: 'Atmospheric Radio-activity.'

T. HOLM: 'Studies in the Cyperaceæ.'

C. E. BEECHER: 'Note on a New Permian Xiphosuran from Kansas.'

C. BASKERVILLE and G. F. KUNZ: 'Kunzite and its Unique Properties.'

R. O. E. DAVIS: 'Analysis of Kunzite.'

E. H. KRAUS: 'Occurrence of Celestite near Syracuse, N. Y., etc.'

L. F. WARD: 'Famous Fossil Cycad.'

H. A. PERKINS: 'Comparison of Two Ways of Using the Galvanometer.'

H. E. MEDWAY: 'Further Work with the Rotating Cathode.'

H. L. BRONSON: 'Transverse Vibrations of Helical Springs.'

D. B. STERRETT: 'New Type of Calcite from the Joplin Mining District.'

J. TROWBRIDGE and W. ROLLINS: 'Radium and the Electron Theory.'

J. P. ROWE: 'Pseudomorphs and Crystal Cavities.'

SOCIETIES AND ACADEMIES.

THE TORREY BOTANICAL CLUB.

THE club met in the morphological laboratory at the New York Botanical Garden, March 30, 1904.

The first paper on the scientific program was 'Notes on the Cytology of the Aquatic Fungi,' by Dr. Cyrus A. King. Schroeter's classification of the Phycomycetes was reviewed and attention called to the fact that the conidia of the Peronosporineæ resemble sporangia since they germinate by forming internal zoospores. In the Saprolegniaceæ, according to Trow, the eggs are at first multinucleate, all except the sexual nucleus in each egg being disposed of by digestion. Dr. King's researches have shown that in the Leptomitaceæ, as far as known, the oogonia are at first multinucleate and the supernumerary nuclei are disposed of by migrating to the periphery of the cell where they are cut off in a distinct periplasm. In *Araiospora* the peripheral nuclei surround themselves with cell walls in such a way that the ooplasm is surrounded by a layer of periplasmic cells. In *Sapromyces* there is also a periplasm in which the nonsexual nuclei are cut off; it is, however, reduced to a very thin layer. The formation of a body in the center of the egg

of *Araiospora* by the coalescence of several small cytoplasmic patches from various parts of the ooplasm was described. The body probably is an attraction center for the sexual nuclei. A similar structure was not found in *Sapromyces*. *Rhipidium* was also briefly described. The presence of a periplasm and the migration of the nuclei from the developing egg indicates that the Leptomitaceæ are more closely allied to the Peronosporineæ than to the Saprolegnineæ. Photomicrographs were shown from Dr. King's preparations showing the facts brought out and showing also indirect nuclear division in the oogonium and zoosporangium of *Sapromyces*.

An interesting discussion followed.

The second paper of the afternoon was by Mr. B. C. Gruenberg and was entitled 'Chemical Investigations on *Hæmatoxylon*.' Hæmatoxylin is one of the most valuable of commercial dyes and the business of supplying the wood from which it is made forms an important industry in some of the West Indies. Considerable annoyance has been caused by the fact that some of the logwood or *Hæmatoxylon* trees contain little or no dye, whole shipments even having been condemned on this account. The so-called 'bastard logwood' is not always to be distinguished at the time of cutting. It is either lighter in color or if dark at first it can be recognized by not becoming still darker on seasoning for some months as does the good wood.

Professor Earle investigated the disease in the field and concluded that the lack of pigment was not due to external conditions, or to disease, or to immaturity, but that the logwood is a variable plant and the bastard form is a variety or subspecies.

The percentage of carbon in the ash-free material was determined for different samples with somewhat varying results, but showing that the good wood contains a slightly higher percentage, due probably to the carbon in the pigment.

Analysis of leaves, stems and roots of one-year-old plants showed that the bastard plants contained slightly more ash and water, but the difference was very slight.

Extracts of the pigment were made with a number of different solvents from varying samples of wood. The extracts with different solvents did not give parallel results as indicating the amount of pigment. In diluting the extracts chemical changes occurred. Alkalies increase the color of extracts of the good wood but not extracts of the bastard wood. Acids have a parallel effect.

Results on the soluble substances in the wood were not satisfactory on account of decomposition on drying. There are probably several pigments.

After a discussion of the paper the meeting adjourned.

William T. Horne,
Secretary pro tem.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting on April 4, Dr. C. Barck read a paper on 'The History of Spectacles.'

The essayist divided the subject into two parts, the development of the industrial art, and the evolution of the scientific selection. In regard to the former, it is an open question whether the Chinese invented glasses prior to the Europeans. Of the ancient nations of western Eurasia, we possess only one relic, namely, a convex lens of rock crystal which was discovered among the ruins of old Nineveh by Sir Layard. To the Egyptians, Greeks and Romans glasses were unknown. The latter assertion does not agree with the common opinion, as expressed in the belief that Nero was near-sighted and used glasses. But this is due to a misinterpretation of a passage of Pliny, as proved at length by the reader of the paper. During the first twelve centuries of the Christian era there is no mention of spectacles; they were invented at the end of the thirteenth century by two Italians, Armati and Spina, either independently or conjointly. This is proved by a number of documents. The essayist then dwelt upon the gradual spread of their use, and the improvement of the frames and lenses. At first only convex lenses were used, concave ones being employed about two centuries afterwards. Cylindrical lenses for the correction of astigmatism, which had been discovered by Thomas Young in 1801, were devised by the astron-

omer Airy in 1827. Bifocals were invented and first used by Benjamin Franklin, 1785. As to the selection of the appropriate lenses, this was at first done by the peddlers who sold them. Physicians for a long time paid no attention to it. Even after the epochal work of the astronomer Kepler had opened a new era in optics by demonstrating the physiology of the act of vision, 1604, physicians maintained their reserved attitude and considered it below the dignity of their profession to have anything to do with the selection of glasses. It was only in the middle of the last century that the change took place. This was due mainly to the labors of Helmholtz and Donders, who laid the foundation for the adjustment of lenses according to mathematical and optical principles. The invention of the ophthalmoscope, by which the refraction can be determined objectively; of the ophthalmometer, which measures the astigmatism of the cornea; and the introduction of remedies, by which the accommodation can be paralyzed followed in rapid succession. By means of these instruments and methods of precision, the medical adviser is governed by well-established laws in the selection of spectacles, and this now belongs to the domain of science. The lecture was illustrated by a number of copies of old paintings and by drawings.

DISCUSSION AND CORRESPONDENCE.

GEO-BIOLOGICAL TERMS.

THE fundamental idea of *bios* is not conveyed by the new terms proposed by Dr. Dall in SCIENCE (No. 494) for indicating collectively 'land and fresh-water organisms.' By analogy with Leibnitz's protogæa, or the primordial world, epigæa would apply to the superficies of the earth, and the literal meaning of namatogæa is 'stream-world.' Correctly formed substantives are geobios and limnobios, proposed by Haeckel as the equivalents of terrestrial and fresh-water faunæ respectively. These may be readily combined in GEO-LIMNOBIOS; or, if an adjective form is desired, AQUA-TERRESTRIAL, or compounds of *terrestris* with *mare, fluvius, lacus*, etc., suggest themselves. *Aqua* having the general significance of fresh water (*aqua pluvia, aqua fontana, aqua cœlestis*, etc.) as opposed to salt, the distinction between aqua-terrestrial and marino-terrestrial is sufficiently obvious. Shorter than any of these, however, is the Greek adjective form, GEO-LIMNOUS.

Those who are in the habit of following the discussion of neologisms in SCIENCE may recall the sprightly flow of opinion that continued for some time in these columns (Vols. V. and VI.) in regard to certain physiographic extravaganza, such as 'Shickshinnies' for synclinal valleys, 'remolino' for pot-hole, 'cuesta' for hill-slope, etc. If we may be forgiven for appearing ironical, it deserves to be pointed out that some of the more euphuistic of the terms proposed about that time are preoccupied. For instance, a round dozen of soft Spanish exotics were imported by Arthur Schott upwards of fifty years ago (*Proc. A. A. A. S.*, 1856, p. 33), but for some reason they failed to germinate. Priority, strictly enforced, might quicken them with new life; then pot-hole, or 'remolino,' would acquire the chastened form of *tinaja*, the homely but expressive 'sink' would give way to *charco*, and base-level to *loma*. The first of these is defined as 'a water-hole in solid rock, usually met with in crevices and ravines of rocky mountains.' *Charco* is a name given to "water-pools found usually in lower and level places. They are formed either by the decay of rocks or by washing out of beds of clay." *Loma* is 'a long narrow mountain or hill-ridge, with a level horizon.'

C. R. EASTMAN.

HARVARD UNIVERSITY.

A REPLY TO CERTAIN CRITICISMS OF PROFESSOR GIARD RESPECTING THE BOPYRIDS.

PROFESSOR ALFRED GIARD, a master in the knowledge of the Bopyridæ, has done me the favor to examine and criticize the results of my recent studies on that group.* Professor Giard has aptly affirmed that a copy of Bonnier's volume 'Contribution à l'étude des Bopyridæ' (*a*)† ought to be found in Wash-

* See *C. R. Soc. de Biologie*, LVI., 1904, April 22, pp. 591–594.

† The letters in parentheses refer to the bibliography at the end of the article.

ington. Unfortunately none of the libraries here has been favored with his work,—not even the Smithsonian Institution, which is very liberal in the distribution of its publications throughout the world. It is to be regretted that the scientific institutions in France have not responded to the offer of exchanges from the Smithsonian Institution and as a result many of their publications are not to be had here. Before the publication of my 'Contributions to the Natural History of the Isopods' (*e*), I made every effort to secure Bonnier's work, without success. After writing to other libraries in this country, I have since succeeded in securing the loan of the volume from the Museum of Comparative Zoology at Harvard College.

With the humility of a disciple, I admit that I was in error (as I discovered before the criticism appeared) in considering that Giard and Bonnier had identified *Grapsicepon fritzi* with the species of *Bopyrus* found by Fritz Müller on an *Alpheus* (*c*). The name *Bopyrus alphei*, it appears, was given by Giard and Bonnier in 1890 (*b*) to the form found by Müller on a species of *Alpheus*, but as no description or figure ever appeared until those I gave in 1900 (*d*), ten years later, I think no zoologist would quote Giard and Bonnier as the authority of the species, a name without a description or figure not being usually accepted. I do not agree with Professor Bonnier in placing *Bopyrus alphei* in the genus *Bopyrella*, for I consider it a true *Probopyrus*, where I have recently placed it, the abdomen of the female being segmented. My figure is misleading, as it shows no segmentation, but, at the time it was made, I could not distinguish any segmentation in the specimen at hand, which was very transparent and colorless. Since receiving other specimens, I have been able to see distinctly the segmentation of the abdomen. In *Bopyrella* the abdominal segments are all fused.

During the short time that Professor Bonnier's work was in my possession, I was not able to examine all that it contains, but I noted the great similarity of my genus *Parapenæon* to his genus *Orbione*. I do not, however, consider my genus a synonym of *Orbione*, for it differs in not having the sixth segment of the abdomen of the female produced into pleural lamellæ, that segment in *Parapenæon* being very small and rounded. In the type species of *Orbione* the pleural lamellæ are produced to such an extent that they reach beyond the extremity of the uropoda. The second species of *Orbione*, *O. incerta*, described by Professor Bonnier, differs in this respect from the type species and may come under my genus *Parapenæon*. The author suggests that the second species of *Orbione* may represent a new genus. The female of *Parapenæon* agrees more with the female of *Cryptione* Hansen than it does with the female of *Orbione*, but the males in the two genera are very unlike. When the male of *Orbione* is known, there may be other characters to differentiate *Orbione* from both *Parapenæon* and *Cryptione*. At present *Parapenæon* is quite as distinct from *Orbione* as *Orbione* is from *Cryptione*.

Urobopyrus Richardson is certainly very close to *Palægyge* Giard and Bonnier, but can not be considered a synonym. In the female of *Urobopyrus* 'the uropoda are a pair of *double*-branched appendages attached to the terminal abdominal segment; the inner branches are smaller and more slender than the outer branches.' The female of *Palægyge* has small, *simple*, rudimentary, knob-like uropoda, not lamellar in shape nor elongated so as to extend beyond the terminal segment as is found in *Urobopyrus*.

In speaking of the thoracic processes in the adult female of *Argeia* as not being of epimeral origin, but arising from the posterior portion of the segment, I made the statement that it was incorrect to refer to them as 'lames pleurales.' My idea was not to suggest that Giard and Bonnier had confounded the 'lames pleurales' with the 'productions épimériennes,' but rather to point out that, in a strict sense, it is not exact to speak of them as 'lames pleurales.' They may be considered as the posterior divisions of the 'lames pleurales,' that view being now generally accepted, the anterior division of the 'lames pleurales' being placed lateral to the ovarian bosses on the anterior portion of the

segments. In *Argeia*, therefore, the 'lames pleurales' are in two parts, an anterior and a posterior part, and it is not exact to refer to these thoracic processes, which arise from the posterior portion of the segments, as the 'lames pleurales' of the segments.

In conclusion, I wish to state that I am not more willing to accept the 'loi naturelle' than I was to accept the 'hypothèse' postulated by Giard and Bonnier until its confirmation has been maintained by facts. Professor Giard states that I have not carefully studied *Argeia pugettensis* coming from different hosts. I hope soon to give in greater détail the results of my researches on this form and on *Bopyroides hippolytes*.

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HARRIET RICHARDSON.

SPECIAL ARTICLES.

AN ACCOUNT OF THE PRELIMINARY EXCAVATIONS IN A RECENTLY EXPLORED QUATERNARY CAVE IN SHASTA COUNTY, CALIFORNIA.

IN the summer of 1902 the writer was commissioned by the department of anthropology of the University of California to search for Quaternary caves in the belt of Carboniferous limestone exposed along the lower portion of the McCloud River. The work of that year led to the exploration of the Potter Creek cave which has already been described in SCIENCE.*

* Wm. J. Sinclair, SCIENCE, N. S., Vol. XVII., No. 435, pp. 708–712, May 1, 1903.

During the summer of 1903 further explorations were carried on by the writer under the direction of Professor J. C. Merriam, in the hope that caves of somewhat later age might be discovered. As a result of this work cave deposits containing remains of Quaternary mammals have been found in several new localities. Of these, the cave containing the largest quantity of remains is so situated with relation to the topography of the region as to indicate that it is younger than the Potter Creek Cave. To this cavern the name Samwel cave has been given, owing to the presence in it of a pool known among the Wintun Indians as 'Samwel,' or spirit water. An Indian legend to the effect that a Wintun maiden had fallen into a very deep well in the cave while searching for water led to the most important discoveries made here.

The Samwel cave is situated on the east bank of the McCloud River and about sixteen miles above its mouth. The entrance is on a Quaternary river terrace. Measurements kindly furnished the writer by Mr. J. S. Diller, who visited the cave with him, show this terrace to be 355 feet above the McCloud River and 1,505 feet above sea level. The entrance is a large, low arched vestibule leading to a series of galleries which widen again to large chambers.

The first chamber is about twenty-five feet long. At the southeast end a vertical fissure about thirty feet high extends twenty feet into the wall. The top is arched over and the bottom is filled with a deposit of clay and stalagmite containing many bones. The highest point on this deposit is near the middle of the fissure. From this place it fans out, fills the farther end and slopes down to the floor of the main chamber where it spreads out. It has been excavated to the depth of four feet, and is seen to be composed of several strata. The whole is covered by a stalagmite capping varying considerably in thickness.

Many remains were taken from this deposit. They include limb bones, vertebrae, teeth, jaws and a large number of splintered bones. In the deposit on the floor of the chamber, near the entrance of the fissure, a dis-

tinctly chipped fragment of black lava was found six inches below the surface. Associated with it were splintered bones and remains of extinct mammals. It is possible that the flint may have fallen in from the surface or worked its way there through a small crevice in the floor, but before commencing excavation the floor had been cleared of all loose material and no crevices were observed. While not of the most conclusive character, the evidence seems to favor original association of the objects found. Bones of several extinct mammals were found cemented to the top of the stalagmite capping.

Following is a list of the species found here:

Ursus americanus Pallas.
Ursus n. sp.
Vulpes sp.
Putorius arizonensis Mearns.
Aplodontia major Merriam, C. H.
Aplodontia near *major* Merriam, C. H.
Aplodontia rufa Rafinesque.
Arctomys sp.
Lepus auduboni Baird.
Thomomys sp.
Thomomys monticola Allen.
Citellus douglasi Richardson.
Sciurus sp.
Erethizon epixanthus Brandt.
Euceratherium sp.
Haplocerus sp.
Odocoileus sp.
Equus occidentalis Leidy.
Elephas sp. (tooth fragment).
Megalonyx sp.

The materials in the fissure deposit had access at some remote date through an opening in the roof. Of this no trace can now be seen, owing to stalactitic growth. Its source was indicated by streams of bones and earth found on projecting ledges and in pockets in the fissure walls.

On the sides of the chamber opposite the fissure several small openings lead to a lower series of galleries, in one of which a large pool of water winds among the rocks. At two places in the lower labyrinth of galleries there are deposits similar to that in chamber one and from these bones and teeth were taken. From the position of these deposits they appear to have entered through fissures leading from some other chamber or from the surface.

High on the south wall of chamber one and difficult of access is an entrance to a second and larger cavern. This has a high arched roof and several tunnel-like grottos lead from it. Through a crevice caused by a fault, a great quantity of earth, angular limestone fragments and gravel have partly filled this room.

At the farthest end of one of the grottos is an oval pit-like opening, which seemed to correspond to the description of the well into which the Indian maiden fell. To explore this pit, holes were drilled in the hard floor of the grotto and into these steel pins were set for the support of a rope ladder. The well was found to widen towards the lower end and was really but the chimney of a large cavern. The skeleton of the Indian maiden lay immediately below the opening and over the greater part of the floor were strewn many bones of bear, cougar and a large extinct goat-like animal.*

The deposit on the floor of this chamber is an accumulation of mud, stalagmite and gravel. This has been excavated, in places, to a depth of four feet, and in that thickness shows six distinctly separated layers of clay, breccia and stalagmite.

Mammal remains were very abundant over the floor and through all the strata excavated. In many instances whole skeletons of carnivores and of rodents were found. There are many complete skulls and numerous dissociated limb bones. The stalagmite encrusting some of the specimens was from one to two inches thick, the bone below the covering being in a perfect state of preservation. Among the fragments are numerous split bones. Some specimens show scorings of rodents' teeth and others bear marks made by the gnawing of large carnivores.

Following is a provisional list of species from this chamber (No. II.):

Ursus n. sp.
Ursus sp.

* *Euceratherium collinum* Sinclair and Furlong. See *Univ. of Calif. Pub. Amer. Archeol. and Ethnog.*, Vol. 2, No. 1, p. 18.

Urocyon townsendi Merriam, C. H.
Procyon near *lotor* Linn.
Felis hippolestes Merriam, C. H.
Mephitis occidentalis Baird.
Mustela sp.
Aplodontia near *major*.
Erethizon epixanthus Brandt.
Lepus auduboni Baird.
Lepus sp.
Microtus sp.
Neotoma fuscipes Baird.
Neotoma sp.
Sciurus sp.
Citellus douglasi Richardson.
Euceratherium collinum Sinclair & Furlong.
Euceratherium n. sp.
Odocoileus sp. (*a*).
Odocoileus sp. (*b*).
Megalonyx sp.

The majority of the remains discovered are those of large carnivora or of cave-inhabiting rodents. This would indicate that these animals have lived in the caves. Such evidence is supported by the fact that the remains of ungulates and other forms which would naturally fall prey to the carnivora are generally much scattered and broken, and in some instances show marks of carnivore teeth.

The position of the present entrance precludes the supposition that any animal could by means of it have gained entrance to this chamber. It is seventy-five feet above the cave floor with a straight drop from top to bottom. The approach to this chimney is through several difficult and tortuous galleries, a route which animals would not follow, as it is far from the light.

Under a portion of the overhanging wall at the southwest side of chamber two, a small fan of stalagmite-covered detrital matter sloping from the outside may mark a former entrance now entirely choked and sealed by the heavy stalagmite growth. It was possibly at this point that animals had access to the chamber, as there is now no outside entrance.

A full report on this investigation will appear later in the Publications of the University of California.

E. L. FURLONG.

UNIVERSITY OF CALIFORNIA,
April, 1904.

VITALITY OF PSEUDOMONAS CAMPESTRIS (PAM.) SMITH ON CABBAGE SEED.

BLACK rot of cabbage and cauliflower, caused by *Pseudomonas campestris* (Pam.) Smith, is a widespread and often destructive disease in the United States. The experience of farmers indicates that the disease may be transmitted by means of the seed; but plant pathologists have doubted this because it seemed impossible that the organism could retain its vitality for several months on dry seeds. *P. campestris* forms no spores. Moreover, Russell and Harding* found that when fresh bouillon cultures were dried at 29° C. on cover slips and kept in darkness 'an exposure of 45 hours invariably sufficed to destroy the vitality of the organisms.'

Recently the writers have investigated this subject and find that *P. campestris* may live on dry cabbage seed for at least ten months. A quantity of cabbage seed was wet with water into which a culture of *P. campestris* had been thoroughly stirred. The seed was then dried and stored in test-tubes in darkness. Some tubes were simply plugged with cotton, while others were plugged with cotton and then sealed with paraffin. Once a month the seeds were tested for the presence of living germs of *P. campestris*. This experiment is unfinished; but at the end of ten months some live germs were found (both in paraffined and in unparaffined tubes) and healthy cabbage plants inoculated with these germs showed the characteristic lesions of black rot in from one to three weeks.

The writers have also proved that germs of *P. campestris* actually do occur on cabbage seed. Four black-rot-infected seed-cabbage plants from Long Island were threshed separately and the seed rinsed in sterile water. Cultures of this water showed the presence of *P. campestris* on three lots of seed. The identity and pathogenicity of these cultures were proved by inoculations into plants. Other portions of the water were injected directly into plants and black rot produced in six out of twelve cases. On combining the re-

* Russell, H. L., and Harding, H. A., 'A Bacterial Rot of Cabbage and Allied Plants,' Wis. Agr. Exp. Sta. Bul. 65: 19.

sults of the two methods the presence of *P. campestris* is shown on the seeds of all four of the seed plants examined.

Full details of these studies will soon appear in Bulletin No. 251 of the New York Agricultural Experiment Station.

H. A. Harding,
F. C. Stewart.

Geneva, N. Y.

A NOTABLE PALEOBOTANICAL DISCOVERY.

The term Cycadofilices proposed by Potonié for the group of synthetic genera, which in Paleozoic times were abundant and widely distributed, and which so curiously combine filicinean and cycadean anatomical characters with foliar organs entirely fernlike in form, seems likely to become a permanent acquisition to taxonomy; although some students, following so eminent an authority as Zeiller, still regard the Cycadofilicales as merely a specialized group of ferns.

The announcement a few months ago* by Professors Oliver and Scott that the gymnospermous seeds named by Williamson *Lagenostoma*, were borne by a species of *Lyginodendron* is most interesting. This identification is based on the identity of the capitate, often stalked, glands, which clothe the enclosing envelope, with those clothing the vegetative organs of *Lyginodendron Oldhamium*. These glands show the closest possible agreement in size, form and structure, and no other known Carboniferous plant possesses them. In addition, the vascular system of the enclosing cupule was well developed, the structure of the large bundle agreeing with the petiolar strand in *Lyginodendron;* and the minute characters in the former are in close agreement with those of the xylem of the foliar organs of the latter, so that the evidence presented is fairly conclusive.

Now *Lyginodendron* with a number of species under a variety of names ranges from the lower Carboniferous into the Permian. The calcified remains, often beautifully preserved and including roots (*Kaloxylon*), stems (*Lyginodendron*) and leaves (*Sphenopteris*) have been associated with the carbonaceous impressions of large finely divided fronds of the *Sphenopteris* type.

The minute structure of these parts is as well known as in living forms, as are the corresponding structures in *Heterangium*, another genus, considered in a general way ancestral to *Lyginodendron* and exhibiting a balance of filicinean characters; while in the latter, though many filicinean characters remain, the cycadean features are more pronounced, the primary bundles are isolated and arranged around a large pith, the vascular bundles both primary and secondary are similar to those of the peduncles in living cycads, and the roots, while agreeing with those of the Marattiaceæ when young, after their secondary thickening are entirely gymnospermous.

The fructifications of this curious plant have hitherto remained unknown, although certain poorly preserved filicinean remains of the *Calymmatotheca* type have been so regarded.*

The structure of the seed as now set forth furnishes a preponderance of gymnospermous features, at the same time emphasizing the combination of transitional characters which distinguish the Cycadofilicales, and furnishes good ground for supposing that many of the plants which furnished the elegant fronds of *Alethopteris, Neuropteris,*† *Sphenopteris*, etc., had already advanced in seed, bearing as far as, if not farther than, the modern Cycads.

The seed under consideration, as does the similar one of *Lagenostoma ovoides*, approaches the cycadean type in that the integument and nucellus are distinct in the apical region only, where the former becomes massive and complicated, consisting of nine chambers radiating from the micropyle. The free portion of the nucellus tapers upward reaching the exterior and plugging the micropylar opening; the separation of the nucellar epidermis from the underlying parenchymatous body of the free part of the nucellus forms a bell-shaped

* Read before the Royal Society, May 7, 1903, and reprinted from the *Proceedings*.

* Described by Benson (Ann. Bot. **18**: 161–177, pl. 11, 1904) and regarded as the microsporangial sori of Lyginodendron.

† In a recent note Professor Oliver (New Phytologist, **4**: 32, 1904) records seeds on the fronds of Neuropteris heterophylla.

pollen chamber, open apically and containing pollen grains in its lower part. The vascular system of the seed consists of nine bundles radiating from a single supply bundle and running to the apex.

It furnishes something more than suggestive evidence of the origin of the Mesozoic Bennettitales and Cycadales, on the one hand, and the Paleozoic Cordaitales and other and later gymnospermous orders on the other hand, from some type of Paleozoic Cycadofilicales, the latter leading back to the true Filicales as recently diagrammatically set forth by Coulter.*

Professor Seward† has styled this discovery of Oliver and Scott as 'one of the most important contributions to botany published in recent years.' The full details, which are promised soon, will be awaited with impatience.‡

EDWARD W. BERRY.

CURRENT NOTES ON METEOROLOGY.

ANTARCTIC METEOROLOGY.

A RECENT number of the *Bulletin of the American Geographical Society* (Vol. XXXVI., 1904, 22–29) contains an account of Dr. Otto Nordenskjöld's Swedish Antarctic expedition of 1902–03, in which are numerous notes of meteorological interest. During five months, beginning with May, there was a period of storms with short intermissions never exceeding three days, during the whole of which period the average wind velocity was 23 miles an hour, and during a whole fortnight it averaged 45 miles. The gales from the southwest brought the lowest temperature recorded. The stormiest day, in June, with a mean wind velocity of 63 miles an hour, was one of the coldest experienced (— 24° F.). The mean temperature for the first year was about 10.2° F.; that of the summer being 28.2° F. The general direction of the winds was southwest, *i. e.*, out from the south polar region.

VERTICAL DECREASE OF TEMPERATURE IN THE FREE AIR.

AT the February meeting of the Royal Meteorological Society in London, Mr. W. H. Dines read a paper on 'Observations by Means of Kites at Crinan in the Summer of 1903,' this being a continuation of the work done in the previous summer, already referred to in these columns. The results of the ascents during August, 1903, show a mean temperature gradient for the first 5,000 ft. of 3.2° per 1,000 feet. This is at the rate of about .59° C. per 100 meters. In the previous summer the average rate per 100 meters was found to vary from .56° C. per 100 meters in a column of 500 meters to .43° C. at 3,500 meters. The averages thus accord quite closely with those given in Hann's 'Lehrbuch der Meteorologie,' pp. 157–161.

THE SAHARA AND THE SOUDAN.

ACCORDING to Sir Frederic Lugard, High Commissioner for Northern Nigeria, the sands of the Sahara are gradually encroaching on the districts of the Sudan which border the desert on the south. Sir Frederic is of the opinion that the desiccation of the country is chiefly caused by the destruction of the young acacias and tamarinds, which are cut down by the natives, and given to the camels for fodder.

MONTHLY WEATHER REVIEW.

THE *Monthly Weather Review* has recently contained an unusual number of articles of general interest. Vol. XXXII., No. 1, 1904, contains an account of the tornado of January 22, at Moundville, Ala. This tornado was first noted about 1.20 A.M., the previous evening having been warm, with fairly heavy rains at intervals, and the wind blowing in heavy gusts from southeast and south. At Moundville nearly every building was demolished, and thirty-six persons were killed and eighty injured, out of a total population of about 300. The storm moved northeast; the

* 'Morphology of the Spermatophytes,' p. 172, 1901.

† Presidential Address, Botanical Section, British Association for the Advancement of Science, Southport, 1903.

‡ These were read before the Royal Society, January 21, 1904, and a new class of seed-plants, the Pteridospermæ, was proposed to include these and similar remains.

path was five miles long, and 250 yards wide at the point of greatest destruction. The funnel-shaped cloud 'had a phosphorescent glow.' Debris from Moundville is reported to have been carried nineteen miles to the northeast. The tornado occurred on the southeast side of a well-marked barometric depression, according to the usual habit of these disturbances.

Concerning lightning rods, Professor W. S. Franklin, in the same number of the *Review*, states that, 'given a good ground connection, then directness of path to ground from the region which is to be protected is so important that the matter of insulating the rod from the building, either by air spaces or by glass, is of no importance whatever in comparison. If the path is direct, there is no need of insulation, and if the path is roundabout, effective insulation is not practically feasible.'

A short article on 'Paths of Storm Centers' brings together a few essential facts regarding the tracks and velocities of cyclones.

NOTES.

It is stated (*Bull. Amer. Geogr. Soc.*, XXXVI., 39) that the front of the Muir Glacier has retreated two and a half miles in four years, which is a higher rate of retrogression than has been observed before. The present indications are that the glacier will before long cease to reach tide water.

During 1903 Mr. W. G. Black, of Edinburgh, collected in an open dish, 8½ inches square, 17 ounces of 'dust and soot.' This would give a fall of 32 ounces per square foot.

R. DeC. Ward.

WILLIAM HENRY PETTEE.

The senate of the University of Michigan has adopted the following memorial as offered by the committee, Professors Prescott and Demmon:

Again the university senate has been sorely stricken, and we are called to record the loss of another of our beloved members. For nearly thirty years he has sat with us in all our deliberations, scrupulously attentive to every official duty, thoroughly informed on all university affairs, courteous, firm and wise. Possessed of a genial and kindly nature, of refined sensibilities and a wide culture, he early won the respect and affection of his colleagues and held these steadily to the end. He has gone from us honored by many years of valuable service to the university, and his loss must continue to be felt in many ways for a long time to come. It seems peculiarly fitting that the senate should come together and spread upon its records some expression of the esteem and love with which we cherish his memory and of our high regard for his services in the great cause of learning, services to which his life was devoted without reserve.

Professor Pettee died at his home on May 26, 1904. He was engaged in his regular duties in the university up to the last evening before his death, but his health had been impaired for nearly a year and his physician had informed him of the uncertain tenure of his life.

William Henry Pettee was born in Newton Upper Falls, Mass., January 13, 1838, of representative New England parentage. His father was a manufacturer of cotton fabrics and of mill machinery. In boyhood his studious tastes had to be restrained and his college preparation delayed out of regard to his somewhat slender bodily frame. He entered Harvard College at nineteen years of age, took high rank in the required classical course of that period, was selected to deliver a Latin oration in the junior year, and graduated with distinction in the class of 1861. He continued in graduate studies in the same university for over three years, receiving the degree of master of arts in 1864, studying at first in the engineering work of the Lawrence Scientific School and then in the college, where at the same time he was an assistant in chemistry under Professor Josiah Parsons Cooke, Irving professor of chemistry and mineralogy and then well known as an author. Mr. Pettee had taken chemistry as his elective subject in his junior year. Of his remaining opportunity for election he had chosen Spanish, in this having the pleasure of reciting for a year and a half to James Russell Lowell. As a chemical assistant, 1863–65, he taught the required chemical physics to the sophomore class and had charge of the elective section of the

juniors in the laboratory. His period of study and travel in Europe was one of three years, from 1865 to 1868. Here his main work was in the Royal Mining Academy of Saxony, at Freiberg, with vacations in the mining regions of Germany.

In 1868 Mr. Pettee returned to Harvard University as a teacher in the school of mining and practical geology then established under the direction of Josiah D. Whitney, the Sturgis-Hooper professor of geology, the director of various geological surveys, including the Lake Superior region and California, and author of works upon the sources of metallic wealth, widely circulated in this country. Mr. Pettee's appointment in 1869 was that of instructor in mining. He was advanced in 1871 to the rank of assistant professor in the same branch, with plans for his work upon the geological surveys to be carried on under the auspices of the Harvard School of Mining.

In the summer of 1869 Professor Pettee made a geological and topographical survey of the South Park of Colorado, a district which had not been covered by the United States geological surveys. In the year 1870–71 he was granted leave of absence for the California State Geological Survey. Besides making a study of gold-bearing gravels, he undertook systematic work in correction of the determination of altitudes by the barometer. Some of the results of this investigation, collected from the detailed reports of the survey, were published by authority of the California State Legislature in 1874, entitled 'Contributions to Barometric Hypsometry,' with Tables for use in California, and a Supplement with Additions in 1878. The work embraced comparisons of the observations taken with the accumulated results of observers in Europe and these could be collected but slowly from scattered publications. A library was formed on the subject. Professor Whitney's estimate of the onerous labor, the accuracy and perseverance of Professor Pettee's work in this undertaking appears in the prefatory note to the volume above mentioned.

From 1871 to 1875 in addition to other duties Professor Pettee gave instruction to an elective section of undergraduates in physical geography, geology and meteorology. Before 1875 the conditions of the gift supporting a school of mining at Harvard were altered and the special instruction in this subject was withdrawn. It was in 1875 that Professor Pettee was appointed to a professorship of mining engineering and related subjects in Michigan. How the turn of events here again released our friend from the limits of a professional specialty has been well stated by his honored colleague, Dean Green, of the engineering department, to whose article on the 'Life of Professor Pettee' this memorial is very much indebted.

In the first semester of 1879–80 Professor Pettee was granted leave of absence from this university to continue his investigation of the auriferous gravels. His report of that work was published as an appendix to the first volume of Whitney's 'Contributions to American Geology' from the Museum of Comparative Geology at Cambridge. It has been adjudged to show that careful examination of phenomena, weighing of evidence, and painstaking accuracy, which those best acquainted with Professor Pettee always expect in papers prepared by his hand.

In the meetings of the faculty Professor Pettee was rarely absent and in them he has naturally served as the undoubted arbitrator upon questions as to previous or conflicting legislation. A member of three faculties, in each he was equally serviceable, and his judgment was asked for more often than offered. He has been annually and inevitably reelected as the secretary of the university senate, and this body owes much to the form he has given to records and reports, both in the making of history and through immediate publication.

It is not possible in this memorial even to enumerate all of the duties, important in administration, to which Mr. Pettee has been assigned. The files of university publications, in college libraries and everywhere, give evidence of the safeguard afforded by his editorial ability. In the organizations affiliated with the university he has been equally helpful.

The annual transactions of the American

Institute of Mining Engineers have been submitted to him for many years, from the publication office in New York, for critical proof-reading and correction. Of this extensive society he is a life member, his election dating from 1871, and he has been a co-worker with its secretary, Rosater W. Raymond. He was one of the original fellows of the Geological Society of America; a fellow of the American Association for the Advancement of Science; in which he was general secretary in 1887; a member of the American Academy of Arts and Sciences during his residence in Massachusetts; and a member of the American Philosophical Society of Philadelphia.

To his colleagues no characteristic of Mr. Pettee was more impressive than his fidelity to truth. Overstatement, exaggeration, disproportionate display were impossible to him. 'True of word and tried of deed' may well be inscribed to his memory as a Christian, gentleman.

Your committee beg leave to recommend that the sincere and profound sympathy of the senate be extended to the bereaved family of our departed friend, and that a copy of this memorial be transmitted to them.

ALBERT B. PRESCOTT,
ISAAC N. DEMMON,
Committee.

EXCAVATIONS IN TURKESTAN.

PROFESSOR RAPHAEL PUMPELLY, who is engaged in explorations in Russian Turkestan under the auspices of the Carnegie Institution, has written a letter to Dr. D. C. Gilman, the president of the institution, in which he says:

The streams that rise in the high mountains of northern Persia emerge on to the Turkoman plains forming fans, or sub-aerial deltas, covering many square miles and each making an oasis. The water is all used in irrigating these fertile spots. Beyond them is the desert. Anau, where we have excavated, is on one of these fans.

Here at Anau, about seven miles east of Aschabad, there are two great tumuli, and the ruins of a city—Anau—surrounded by moat and wall, and occupied till within the last century. The two tumuli, nearly half a mile apart, are nearly equidistant from the city at a distance of less than a mile. We have explored both of these tumuli and I have done some work in the city.

The northern and older tumulus rises 40 feet *above the plain;* the southern and younger tumulus rises 52 feet *above the plain.* Both of these start with their lowest culture strata on slight elevations in the same original plain-surface—more than 20 feet below the present surface of the surrounding plain. That is to say, the plain has grown up more than 20 feet since the settlements began. I will show, further on, the different phases of this growth.

In the older tumulus, we find a culture occupying the lower 45 feet, and distinguished by the technique and decoration of its wholly handmade and interesting pottery. This is succeeded in the upper 15 feet by a more advanced culture in which the finding of some remnants of bronze implements and lead beads (all wholly altered to salts of the metals) show a beginning acquaintance with bronze, while the still handmade pottery has changed and become more developed. Throughout this tumulus we have found nothing recognizable as a weapon of offense in either stone or metal, though flint knives abound.

The southern, younger tumulus, starts with a developed wheel-made pottery, unpainted and of a technique wholly different from that of the older tumulus—though some hand-made pottery occurs not unlike some of the younger products of the older tumulus.

From its base under the plain to its summit this tumulus has 74 feet of culture strata. There are evident here at least two sucessive cultures. Of these, that of the lower 62 feet is wholly in the bronze stage (but with survival of flint implements), while the upper 14 feet are marked by decided changes and by the introduction of iron, of which the wholly oxidized remnants of some implements were found.

We have thus at least four distinct cultures occupying 136 feet, with a break in the column between the end of the old and the beginning of the new tumulus. We do not know how great this gap may be, but the presence of

some fragments of wheel-made pottery on the surface of the older tumulus, as well as in the neighboring irrigation column, seems to represent a transition from the older to the newer. This suggests the possibility that the gap was filled by the strata which has disappeared through wind and water erosion, and which must, in any event, have been of considerable thickness.

Through all the cultures except the last—that of the iron stage—there ran a remarkable and characteristic burial custom. The children—at least certain children—and seemingly only children, were buried in the houses, under the floor, in a layer of fire-hardened earth. I was struck last year by the fact that all the human bones I sent from here to Professor Zittel were those of children. The skeletons lie on the side with the knees drawn up in the 'liegende höcker' position. With them have been found beads of turquoise, lapis lazuli, carnelian and other minerals. Eighteen of such burials have been studied.

THE GOLDEN TROUT OF MT. WHITNEY.

THE most beautiful and in many respects the most interesting of all the trouts is the famous golden trout of Mount Whitney. It is known only from a few small mountain streams high up in the Sierras on the western slopes of Whitney, the highest mountain in the United States. It was formerly abundant in Volcano Creek, tributary to the South Fork of Kern River, and has been introduced into Cottonwood Creek and perhaps other streams on the east slope of the Sierras, tributary to Owens Lake. Its original home seems to have been Volcano Creek and in that stream only above the falls.

During the last few years many camping parties have gone into the region and reports have reached the Bureau of Fisheries that the species is in danger of extermination. Recently Stewart Edward White, the author of 'The Blazed Trail,' called attention to the danger, and President Roosevelt, the true naturalist that he is and always alive to more matters of interest than any one else, addressed a letter to the Commissioner of Fish and Fisheries, asking that an investigation be made to determine what steps should be taken for its preservation.

In compliance with the President's request, Commissioner Bowers is sending a party to the Mount Whitney region to find out all they can about the golden trout. It is intended to determine its present distribution, in what streams it is now found, into what it has been transplanted, into what additional streams it might be introduced, and whether the species can be propagated artificially. It is believed there will be no difficulty with cultivating the species if a few individuals for breeding stock can be gotten to one of the government fish hatcheries. This will not be an easy task, as the fish will have to be carried on pack-horses for 24 to 48 hours down the east slope of the Sierras through a semi-desert region to Lone Pine, or 3 or 4 days to Visalia.

The expedition that will conduct these investigations will be under the immediate direction of Dr. Barton W. Evermann, assistant in charge Scientific Inquiry in the Bureau of Fisheries. The other members of the party will be Dr. Oliver P. Jenkins and Professor Rufus L. Green, of Stanford University, Professor Chancey Juday, of the University of Colorado, and Captain Charles B. Hudson, the artist, who will paint the golden trout in life colors. Professor Juday will make a special study of the food and feeding habits of the trout, Professor Green will study the physical characters of the streams to be examined, while Drs. Evermann and Jenkins will give their attention to the biological and fish-cultural problems involved and to the geographic distribution of the species. The party will outfit early in July at Visalia, California, with pack outfit and enter the High Sierra by way of Three Rivers and Mineral King. About a month's time will be devoted to the investigations and it is believed that the results will be of great interest to anglers and fish-culturists.

SCIENTIFIC NOTES AND NEWS.

HARVARD UNIVERSITY has conferred the degree of doctor of laws on Dr. William Osler, professor of medicine at the Johns Hopkins University.

Yale University has conferred the degree of doctor of laws on President Charles R. Van Hise, of the University of Wisconsin, and on Dr. W. S. Halsted, professor of surgery in the Johns Hopkins University.

Amherst College has conferred the degree of doctor of laws on Dr. J. H. Tufts, of the class of 1884, now head of the department of philosophy of the University of Chicago.

Hamilton College has conferred the doctorate of science on Dr. E. S. Burgess, the botanist, professor of natural science in the Normal School, New York City.

Dr. A. W. Harris, president of the Jacob Tome Institute and formerly director of the Office of Experiment Stations of the U. S. Department of Agriculture, has been given the doctorate of science by Wesleyan University, where he graduated in 1880.

Mr. Theodore N. Ely, chief of motive power of the Pennsylvania Railroad, has been made a doctor of science by Hamilton College.

Dr. E. Pflüger, the eminent physiologist of the University of Bonn, recently celebrated his seventy-fifth birthday.

Dr. Roux has been elected director of the Pasteur Institute in the room of the late M. Duclaux. Drs. Chamberland and Metchnikoff have been elected sub-directors of the institute.

Dr. Michelerhana, of the Observatory at Milan, has been made director of the Observatory at Bologna.

President Roosevelt has appointed Rear Admiral Robley D. Evans, Rear Admiral Henry N. Manney, Brigadier-General A. W. Greely, Lieutenant-Commander Joseph L. Jayne and Professor Willis L. Moore, chief of the Weather Bureau, a board to consider the question of wireless telegraphy in the service of the government.

Dr. Robert Koch has returned to Berlin after his investigations in southwest Africa, where he has been engaged for nearly a year and a half.

It is reported that Captain Bernier will start in a fortnight for the polar regions. The arctic steamer *Gauss*, recently purchased from the German government, is now being refitted and provisioned at Quebec, and she will probably go to Halifax to secure part of her crew. She will then proceed around Cape Horn to Vancouver, and thence to Herschell Island, at the mouth of McKenzie River, with a party of Northwest mounted police to relieve the party stationed at that post. From that point Captain Bernier will make an effort to reach the pole.

Professor F. W. Rane, of the New Hampshire College of Agriculture, is spending the summer studying forest conditions in the northwest.

The address on 'The Continuous Advance of Electrochemistry,' by Professor Joseph W. Richards, published in the issue of Science for June 17, was the presidential address before the Electrochemical Society, delivered at Washington on April 8, 1904.

It is hoped that the statue of Pasteur on the Place de Breteuil, Paris, will be unveiled on the thirteenth of July, the day of the national fête.

The Berlin municipal council has decided to erect, at the cost of the city, a monument in honor of Rudolf Virchow.

Dr. Frederick Knapp, for many years professor of applied chemistry in the Chemical Institute at Brunswick, died on June 8, in his ninety-first year. Dr. Knapp was a former student and a son-in-law of Liebig's.

The deaths are also announced of M. Victor de Luynes, professor of the Paris Conservatory of Arts and Measures; of Professor Carl Weibrecht, director of the Technological Institute of Stuttgart, and of Dr. Albert Rilliet, associate professor of physics in the University of Geneva.

A new museum of anthropology has been established at Hamburg.

M. Charles E. Potron has bequeathed 20,000 francs to the French Geographical Society.

The American Institute of Electrical Engineers held a meeting at Chicago under the presidency of Mr. Bion J. Arnold. The meeting was devoted to a discussion of high tension transmission.

MR. ANDREW CARNEGIE has given to the British Museum the restoration of a skeleton of Diplodocus, made under the direction of Mr. J. B. Hatcher. Invitations were sent by Dr. E. J. Holland, director of the Carnegie Museum, to view the restoration on June 30.

THE council of the jubilee foundation for German industry, which recently met in Berlin, has made appropriations, amounting to over $12,000. Among the subsidies is one of $2,500 to Dr. Garbe, of Berlin, to study the American railway system, and one of $1,200 to Professor Nernst at Göttingen for researches at high temperatures.

AT the forty-fifth meeting of the Society of German Engineers, held recently at Frankfort, it was announced that the lexicon of technology undertaken by the society is about half completed. The cost of this work will be over $100,000, for which the society has made itself responsible.

A LABORATORY for the study of beet sugar manufacture, a branch of the Agricultural School of Berlin, was opened on May 8.

THE London *Times* states that Mrs. Percy Sladen, of Northbrook-park, Devonshire, in the desire to perpetuate the memory of her late husband, Mr. Walter Percy Sladen, sometime secretary and vice-president of the Linnæan Society, has undertaken to devote the sum of £20,000 to the promotion of scientific research, particularly in the subjects in which he was chiefly interested. She proposes to assign this sum under the name of the Percy Sladen Memorial Fund to certain trustees, in the first place of her own appointment, who are directed to employ the income arising therefrom, in their uncontrolled discretion, to 'any research or investigation in natural science, and more especially in the sciences of zoology, geology and anthropology.' They are also empowered, if they think fit, to accumulate the income for the purpose of fitting out, or assisting to fit out, any expedition designed to further such research. The following gentlemen, whom Mrs. Sladen has requested to be the first trustees, have consented to serve: Her brother, Dr. Tempest Anderson, of York; Mr. Bailey Saunders, Mr. Henry Bury, Dr. Henry Woodward, F.R.S., Professor Howes, F.R.S., and Professor Herdman, F.R.S. On the occurrence of any vacancy among these trustees Mrs. Sladen reserves to herself the right to nominate their successors; but by the deed of endowment it is provided that eventually five trustees shall be severally nominated for a period of five years each by the following bodies in rotation, so far as they may have signified their acceptance of the power of appointment; the Royal Society, the Linnæan Society, the trustees of the British Museum and the Universities of Oxford and Cambridge.

FROM September 15 to 18, 1903, a conference of the engineers of the Reclamation Service was held at Ogden, Utah. At the time of this meeting the Reclamation Service had been in active operation for over a year and projects in each state had reached a point at which their relative merits demanded consideration. It was, therefore, deemed advisable to bring the principal engineers together, in order to discuss somewhat informally the methods and results of work. The eleventh irrigation congress was in session then at Ogden, and delegates were in attendance from the thirteen states and three territories named in the reclamation law, as well as from Texas and the country farther east. The engineers of the Reclamation Service were thus enabled to meet public men and others who are interested in the work of irrigation and to exchange views freely with them. The proceedings of this conference of reclamation engineers, compiled by Mr. F. H. Newell, chief engineer, have been recently published by the United States Geological Survey as No. 93 of its series of Water-Supply and Irrigation Papers, a volume of about 350 pages filled with valuable data. Besides the purely technical discussions and addresses, the paper includes several interesting speeches made to the engineers by various governors, senators and other prominent people. It is published for gratuitous distribution and may be obtained by application to the Director of the U. S. Geological Survey, Washington, D. C.

THE Paris correspondent of the London *Times* reports that some fifty men of science

assembled on June 19 at the house of the Prince of Monaco to listen to a paper read by M. Charles Rénard, a member of the permanent committee of the International Naval Association, on a new scheme for a polar expedition. M. Bénard holds that only two kinds of exploration in the polar basin are at present rational—namely, annual explorations along the perimeter of the Arctic Circle, like that of the Prince of Monaco in Red Bay or that of Greely in Port Conger Bay, or else great expeditions well within the Polar Sea, with special boats fitted up as observatories and laboratories, solid enough to resist the ice pack, and capable of carrying provisions for the length of time required by the itinerary. M. Bénard explained at length why the only feasible and rational route of penetration of the Polar Sea is one a little north of that followed by the *Fram*. The expedition ought to start from a Norwegian port, cross the southern portion of Barents Sea, take in dogs at Karabora, coast along Yalmal, ship at Port Dickson its coal, transported thither by special steamer, pass at the end of the summer along the Peninsula of Taimyr, arrive by the end of the autumn at the islands of New Siberia, and then, instead of going northward, as did the *Fram*, manage at all costs, even if it be necessary to winter in the Liakhoff or Bennett Islands, to reach a point on the 150th degree of east longitude. Thence the ship or ships need only drift with the ice. M. Bénard urged the utility of having the expedition composed of two vessels in touch with each other by means of wireless telegraphy. The expedition should take three years, but be provisioned for five. It would not cost more than $300,000. The company signed a memorandum declaring this expedition to be of scientific utility.

It is stated in the London *Times* that the man-lifting kite, as invented by Mr. Cody, has during the last few days been subjected to further trials at Aldershot with the view of testing its feasibility and usefulness for observation purposes in war time. The main features claimed for the kite are, first, its extreme simplicity and the ease with which the various component parts required to work it can be transported from place to place; and, secondly, that it can be flown in heavy wind such as would render the use of the war balloon almost impossible. A number of Royal Engineers are now under instruction in the working of the kite in order that it may be thoroughly tested.

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. Henry Whitman, of Boston, has made public bequests aggregating more than $200,000, including $110,000 to Radcliffe College and $10,000 to Harvard University.

Mr. George Ehret, of New York, has given $10,000 to the permanent fund of Hamilton College.

The Secretary of the Interior has approved the application of the board of trustees of the Columbian University of Washington to change the name of that institution to the George Washington University.

Dr. C. Alphonso Smith, professor of English literature at the University of North Carolina, has been elected president of the University of Tennessee, succeeding Dr. Charles W. Dabney, who has become president of the University of Cincinnati.

Professor George S. Williams, of the College of Civil Engineering, in Cornell University, has resigned to accept the chair of civil engineering in the University of Michigan, made vacant by the death of Professor Greene.

Carl C. Thomas, instructor in marine engineering at the University of California, has accepted a call to Cornell University to the assistant professorship in marine engineering at Sibley College. He will succeed Professor William F. Durand, principal of the graduate school in marine engineering, who has been called to Stanford University.

Dr. T. F. Nichols has been appointed professor of applied mathematics at Hamilton College.

Dr. C. C. Stewart, of the University of Pennsylvania, has been appointed professor of physiology at Dartmouth College. At the same institution C. A. Holden, in mathematics, and G. R. Lyman, in botany, have been appointed to assistant professorships.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 15, 1904.

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THE AGE OF SCIENCE.*

As much of the time of those who go forth from this institution to-day has been spent in the study of the sciences, it has seemed to me fitting to ask your attention to some considerations suggested by the phrase, 'This is the age of science.' I do not remember ever to have heard this statement questioned, much less denied, nor do I remember ever to have heard it satisfactorily explained. It sounds simple enough, and does not appear to call for explanation or comment, and yet I think it worth while to examine it a little more carefully than is customary, to see in what sense it is true. For in a sense it is true, and in a sense it is not true. The statement raises two questions which should be answered at the outset. These are: (1) What is science? and (2) In what sense is this the age of science?

First, then, what is science? Surely there can be no difficulty in answering this, and yet I fear that, if I should pass through this or any other audience with the question, I should get many different answers.

A certain lady, whom I know better than any other, has told me that, should she ever be permitted to marry a second time, she would not marry a scientific man, because scientific men are so terribly accurate. I often hear the same general idea expressed, and it is clear that accuracy is one attribute of science according to prevailing opinions. But accuracy alone is not science. When we hear a game of baseball or of whist spoken of as thoroughly scientific, I sup-

* Commencement address delivered at Worcester Polytechnic Institute, June 9, 1904.

pose the idea here, too, is that the games are played accurately; that is, to use the technical expression, without errors.

Again, there are those who seem to think that science is something that has been devised by the Evil One for the purpose of undermining religion. This idea is not so common as it was a few years ago, when the professors of scientific subjects in our colleges were generally objects of suspicion. The change which has come over the world in this respect within my own memory is simply astounding. In general terms an agreement has been reached between those who represent religion and those who represent science. This agreement is certainly not final, but it gives us a *modus vivendi,* and the clash of arms is now rarely heard. Religion now takes into consideration the claims of science, and science recognizes the great fundamental truths of religion. Each should strengthen the other, and in time, no doubt, each will strengthen the other.

Probably the idea most commonly held in regard to science is that it is something that gives us a great many useful inventions. The steam-engine, the telegraph, the telephone, the trolley car, dye stuffs, medicines, explosives—these are the fruits of science, and without these science is of no avail. I propose farther on to discuss this subject more fully than I can at this stage of my remarks, so that I may pass over it lightly here. I need only say now that useful inventions are not a necessary consequence of scientific work, and that scientific work does not depend upon useful applications for its value. These propositions, which are familiar enough to scientific men, are apt to surprise those who are outside of scientific circles. I hope before I get through to show you that the propositions are true.

Science, then, is not simply accuracy, although it would be worthless if it were not accurate; it is not devised for the purpose of undermining religion; and its object is not the making of useful inventions. Then what is it? One dictionary gives this definition: "Knowledge; knowledge of principles and causes; ascertained truth or facts. * * * Accumulated and established knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws, * * * especially such knowledge when it relates to the physical world, and its phenomena, the nature, constitution and forces of matter, the qualities and function of living tissues, etc."

One writer says: "The distinction between *science* and *art* is that *science* is a body of principles and deductions to explain the nature of some matter. An *art* is a body of precepts with practical skill for the completion of some work. A *science* teaches us to know; an *art,* to do. In *art,* truth is a means to an end; in *science* it is the only end. Hence the practical arts are not to be classed among the sciences." Another writer says: "*Science* and *art* may be said to be investigations of truth; but one, *science,* inquires for the sake of knowledge; the other, *art,* for the sake of production; and hence *science* is more concerned with the higher truths, *art* with the lower; and *science* never is engaged, as *art* is, in productive application."

Science, then has for its object the accumulation and systematization of knowledge, the discovery of truth. The astronomer is trying to learn more and more about the celestial bodies, their motions, their composition, their changes. Through his labors, carried on for many centuries, we have the science of astronomy.

The geologist has, on the other hand, confined his attention to the earth, and he is trying to learn as much as possible of its composition and structure, and of the processes that have been operating through

untold ages to give us the earth as it now is. He has given us the science of geology, which consists of a vast mass of knowledge carefully systematized and of innumerable deductions of interest and value. If the time should ever come when, through the labors of the geologist, all that can possibly be learned in regard to the structure and development of the earth shall have been learned, the occupation of the geologist would be gone. But that time will never come.

And so I might go on pointing out the general character of the work done by different classes of scientific men, but this would be tedious. We should only have brought home to us in each case the fact that, no matter what the science may be with which we are dealing, its disciples are simply trying to learn all they can in the field in which they are working. As I began with a reference to astronomy, let me close with a reference to chemistry. Astronomy has to deal with the largest bodies, and the greatest distances of the universe; chemistry, on the other hand, has to deal with the smallest particles and the shortest distances of the universe. Astronomy is the science of the infinitely great; chemistry is the science of the infinitely little. The chemist wants to know what things are made of, and, in order to find this out, he has to push his work to the smallest particles of matter. Then he comes face to face with facts that lead him to the belief that the smallest particles he can weigh by the aid of the most delicate balance, and the smallest particles he can see by the aid of the most powerful microscope, are immense as compared with those of which he has good reason to believe the various kinds of matter to be made up. It is for this reason that I say that chemistry is the science of the infinitely little.

Thus have I tried to show what science is and what it is not. Now let me turn to the second question.

In what sense is this the age of science? In the first place, it is not true that science is something of recent birth. Scientific work of one kind and another has been in progress for ages—not in all branches, to be sure—but nature has always engaged the attention of man, and we may be sure that he has always been trying to learn more about it. The science of astronomy was the first to be developed. Astrology was its forerunner. Then came chemistry in the guise of alchemy. It would be interesting to follow the development of each, and to see how from the crude observations and imaginings of the earlier generations came the clearer and broader conceptions that constitute the sciences, but time will not permit us to enter upon this subject. I can not, however, do justice to my theme without calling your attention to one of the most serious obstacles that stood in the way of the advance of knowledge.

To make clear the nature of this obstacle, it will be best to make a comparison. A child learns a great deal in regard to his surroundings in his earliest years before he goes to school, and without the aid of his parents. He is constantly engaged in making observations and drawing conclusions, and his actions are largely guided by the knowledge thus gained. After a time school life begins, and the child then begins to study books and to acquire knowledge at second-hand. This is an entirely different process from that by which he gained his first knowledge. The latter is natural, the former is artificial. Then, too, he soon discovers that many things he sees call for explanation, and he is led to wonder what the explanation is. If he has a strong imagination, as most children have, he will probably think out some explanation. He finds that he can use his mind, and that this helps him in dealing with the facts in

nature. Now comes the danger. It being much easier to think than to work, the chances are that in trying to find the explanation of things, he will give up the natural method and be satisfied with the products of his imagination. He will gradually give up dealing directly with things, and take to thinking alone. When this stage is reached his knowledge will increase very slowly, if at all.

Whether this picture of the development of a child is in accordance with the facts of life or not, it gives an idea of the mental development of mankind. First came the period of infancy, during which observations were made and much learned. Efforts were early made to explain the facts of nature. We have remnants of these explanations in old theories that have long ceased to be useful. They no doubt served a useful purpose in their day, but gradually one of the most pernicious ideas ever held by man took shape, and I am willing to characterize it as one of the most serious obstacles to the advance of knowledge. I refer to the idea that it is a sign of inferiority to work with the hands. This idea came early and stayed late. In fact, there are still on the earth a few who hold it. How did this prove an obstacle to the advance of knowledge? By preventing those who were best equipped from advancing knowledge. The learned men of the earth for a long period were thinkers, philosophers. They were not workers in nature's workshop. They tried to solve the great problems of nature by thinking about them. They did not experiment. That is to say, they did not go directly to nature and put questions to her. They speculated. They elaborated theories. During this period knowledge was not advanced rapidly. It could not be. For the only way along which advances could be made was closed.

Slowly the lesson was learned that the only way by which we can gain knowledge of nature's secrets is by taking her into our confidence. Instead of contemplation in a study, we must have contact with the things of nature either out-of-doors or in the laboratory. Manual labor is necessary. Without it we may as well give up hope of acquiring knowledge of the truth. When this important fact was forced upon the attention of men, scientific progress began and continued with increasing rapidity. At present the old pernicious idea that a man who does any kind of work with his hands is by virtue of that fact an inferior being—that idea is no longer generally held. But we have not got entirely rid of it. In a recent address I find this reference to the subject: "However the case may have been with what forty years ago was called the education of a gentleman, it seems to me to be one of the services of the scientific laboratory that it has taught to that part of mankind which has leisure and opportunities that manual skill is a thing to be held in honor both as a means for reaching mechanical results, and still more, as a way to train the mind. * * * Fifty years ago many men who called themselves educated were mere untrained, undeveloped children in manual skill, and some of them were proud of their incompetency, for nothing would have more surprised them than an assertion that their inability to help themselves with their hands was a badge of ignorance. * * * While the high character and sterling worth of the medical man has always won respect, their skill in the use of their hands was long held by those who were superior to such weakness to place them beneath the lawyers and the clergymen in the social scale." Recently I came upon this old idea within college walls. In the college connected with the Johns Hopkins University there are several groups of studies which lead to the degree of bachelor of arts.

Group I. is largely made up of the classics, and it is therefore generally called the classical group. I happened once to be dining with a gentleman whose son was a student in Group I. in our college. Our professor of Latin was also present. Turning to my colleague, the professor of Latin, our host, the father of the classical student, exclaimed: 'How those fellows in Group I. look down upon all the others!' I afterwards learned that this feeling undoubtedly existed among the students, those who studied the classics, especially, forming, in their own opinion at least, a well-characterized aristocracy. I have referred to these cases simply for the purpose of showing that the pernicious idea that hand-work is a sign of inferiority is not yet dead. But it has nevertheless been disappearing rapidly for some years past, and with its disappearance the development of science has kept pace. Which is the cause and which the effect it would perhaps be hard to say. At all events, the growth of every department of science has been more rapid within the last fifty years than during the preceding fifty years, though we should be doing gross injustice to our predecessors were we to belittle their work. The fact is, I am inclined to think that there never was a more fruitful period, in chemistry at least, than the last quarter of the eighteenth century. Farther on, I shall have occasion to speak of a few of the great chemical discoveries that were made during that period. No greater discoveries have been made since. In astronomy, Newton's great work was done more than two centuries ago. An age that can boast of the discovery of the law of gravitation may fairly lay claim to the title, 'the age of science.' Many and many a great discovery in science preceded the present age, but from what I have already said, you will see that the reason for calling this age in which we live the scientific age is found in the fact that scientific work is much more extensively carried on at present than at any time in the past, and, further, the world is beginning to reap the rewards of this work. So striking are some of these rewards that they appeal to all. The world is dazzled by them, and is to a large extent unable to distinguish between the scientific work which has made these rewards possible and the rewards themselves. The idea is prevalent that scientific work is carried on in order that rewards in the shape of practical results may be reached. I have no desire to bring my fellow-workers in science into disrepute. It would therefore perhaps be best for me to stop here; but, if you will bear with me, I will try to make it clear to you that one may be engaged in scientific work all his life, never thinking of what the world calls practical results, that he may in fact not achieve a single result that can be called practical, and yet not waste his time; and that one may hold such a worker up to admiration without running much risk of being taken for a fool. This will be my object in what I still have to say.

While I have thus far referred to science in the broadest sense, meaning the science of nature, let me now turn more especially to the science to which it has been my lot to devote my life, and let me endeavor to show by a few examples the relations that exist between work that appears to be of little practical value when first performed and results that, from the industrial point of view, are of the highest value.

I have often been embarrassed by these questions put to me in my laboratory: 'What are you doing?' and 'Of what use is the work?' Generally I am obliged to answer to the first, "I regret that I can not possibly explain what I am doing. I have tried to do so in some cases, but I have been begged to stop"; and to the second, the only possible answer has been, 'I do not

know.' I am well aware that such answers seem to show that the work is in fact of no value, and that this is the impression that my visitors carry away with them. Now I do not propose to try to justify my own work, nor to try to explain it. For the most part it has had to deal with matters that do not touch our daily lives, and therefore it can not be made interesting, not to say intelligible. I shall, to be sure, show you how one piece of work carried out twenty years ago has become of world-wide interest, though when it was carried out it appeared as little likely to be of practical value as anything ever done. But this is anticipating.

During the latter half of the last century there lived in Sweden a poor apothecary who, in his short life, probably did more to enlarge our knowledge of chemistry than any other man. Throughout his life he had to contend with sickness and poverty. He was obliged to carry on the business of an apothecary in order to keep the wolf from entering his house—he never succeeded in keeping it from the door. His great delight was to investigate things chemically, and to find out all he could about them. It is simply astounding to the chemist to find how many discoveries of the highest importance he made. But I have not mentioned his name. I refer to the immortal Scheele. He died in the year 1786 at the age of 43, yet he will always be remembered, and those who know most of the work he did will respect him most.

Though Scheele was an apothecary, his chemical work was not practical in the ordinary sense, and it was no doubt often difficult for him to explain what he was doing. His most important discovery was that of oxygen—a discovery that was made at the same time (1774) by the English clergyman, Priestley. Chemists know that this is one of the most important discoveries ever made in the field of chemistry, and, filled with this conviction, in 1874, one hundred years after the discovery was made, the chemists of the United States made a pilgrimage to Northumberland on the Susquehanna to do honor to the memory of Priestley, who there spent the last years of his life.

But why was this discovery so important? Oxygen, to be sure, is the most widely distributed and the most abundant substance in and on the earth; it plays a controlling part in the breathing of animals, and in most of the changes that are taking place upon the earth; a knowledge of it and of the ways in which it acts has done more than anything else to give chemists an insight into chemical action in general; and therefore has contributed more than anything else to the development of chemistry. All this is no doubt true, but are these results practical? Could we go out into the world and form a company and sell stock on the basis of such a discovery? Or could the discoverer in any way realize in cash? The average man of the world would say: "No! there is nothing in it. It may be well for a few men who have not the power to compete with their fellow-men in the busy marts to devote themselves to such useless pursuits. Possibly something may come of it in time, but better something practical, something that can be converted into hard cash. That is the test, and the only fair test by which we can judge whether any particular piece of scientific work is or is not of value."

But I have already said that the discovery of oxygen was the most important discovery ever made in chemistry, and I might have added, the most valuable. In what, then, did its value consist? In the fact that it led to a more intelligent working with all things chemical. Operations that had before this discovery appeared mysterious suddenly became clear, and every one engaged in chemical work was helped

in many ways. If it is not enough for us simply to gain a clearer insight into the processes around us, if we must insist upon more tangible reward, no doubt it could be shown that the discovery of oxygen has contributed largely to the material welfare of mankind—not directly perhaps, but by enlarging our knowledge of chemistry, so that it may be said that most discoveries made since 1774 have been in a way consequences of the discovery of oxygen. Indirect results are often of more value than direct ones.

But there is another discovery of Scheele's that illustrates in another way that a discovery that when made appears of little or no practical value, may eventually prove of immense practical value and become the basis of a great industry. This is the discovery of chlorine. Among the many substances examined by Scheele was one that is commonly known as black oxide of manganese. This occurs in nature in large quantity and has long been of interest to chemists. Scheele treated this with about everything he could lay his hands on, as was his way. When muriatic acid, or, as it was called by the older chemists, the spirit of salt, was poured on the black oxide of manganese, he noticed that something unusual took place. He soon became aware that a colored gas was given off, and that this gas had other properties besides that of color. It affected his eyes, nose, throat and lungs in most disagreeable ways. Many of those before me have had the experience of inhaling a little of this gas. I hope no one has inhaled much of it. It is one of the most disagreeable things chemists and students of chemistry have to deal with. And it is not only disagreeable, it is extremely poisonous. But Scheele did not stop his work because it involved discomfort and even danger. He persisted and carried it to a successful issue, and when he stopped he was able to give as satisfactory an account of the now familiar chlorine as we can give to-day. The investigation is a model. It could not have been accomplished without the enthusiasm, the patience, the knowledge and the skill possessed by Scheele. No ordinary chemist would have been equal to it. We shall not overstate the case if we say that Scheele's discovery of chlorine ranks with the most important and the most valuable of chemical discoveries. That of oxygen outranks it certainly, but chlorine falls in line not far behind.

Now, why was this an important and a valuable discovery? Primarily because it, like the discovery of oxygen, though to a less degree, aided chemists in their efforts to understand chemistry and thus to put them in a position to deal more intelligently with chemical problems of all kinds. That statement may, once for all, be made of every important chemical discovery. But while Scheele had no thought of any practical uses to which chlorine could be put, and his discovery was not at first regarded as one with a practical bearing, it proved eventually to be of the highest practical value, and to-day it plays an exceedingly important part in practical affairs. As is well known, chlorine is the great bleacher, and as such is used in enormous quantity, especially for bleaching straw, paper and different kinds of cloth. As it would be expensive and inconvenient to transport a gas, and especially such a gas as chlorine, it is locked up, as it were, by causing it to act upon lime, and the 'chloride of lime' or 'bleaching powder' thus formed, which readily gives up its chlorine, is a most important article of commerce, many thousands of tons being manufactured annually. Then again chlorine is one of the most efficient disinfectants, and as such it is finding more and more extensive use every year, and is plainly contributing to the welfare of man by interfering with the spread of

disease. Further, it is essential to the manufacture of chloroform, and that this calls for a large quantity of chlorine will appear when it is stated that nearly nine tenths of the weight of chloroform is chlorine. Chloroform, which has been of such inestimable value as an alleviator of pain, can not be manufactured without chlorine, and it could never have been discovered without the previous discovery of chlorine.

Finally, without attempting to give a full account of all the uses to which chlorine has been and is put for our benefit, let me mention one more application, though in doing so I may run the risk of leading some of you to the conclusion that chlorine has its dark side as well as its light. It is with some misgivings that I venture to tell you that chlorine has found extensive application in the extraction of gold from its ores, and as gold is held by some to be the root of all evil, chlorine must, by the same token, be regarded as *particeps criminis*. A few years ago I visited the gold mines in the Black Hills of South Dakota, and there I spent some time in examining the chlorination process. I could not help thinking of Scheele and his simple experiments that first brought chlorine to light. I wondered whether, if he could see the extensive applications of that greenish-yellow gas that first set him to weeping and coughing—I wondered whether his satisfaction in his work would be any greater than it must have been when the discovery was made. Compare the little room in the apothecary shop, the simple apparatus, and the apparent uselessness of the noxious gas with the great factories, the complicated machinery and the valuable applications already mentioned, and it is evident that a discovery that appears least promising from the practical point of view may be the beginning of the most valuable industries.

Before leaving this part of my subject let me take a much less important example than those already spoken of, but one that comes nearer home. Nearly twenty-five years ago in the laboratory under my charge, an investigation was being carried on that seemed as little likely to lead to practical results as any that could well be imagined. It would be quite out of the question to explain what we were trying to do. Any practical man would unhesitatingly have condemned the work as being utterly useless, and I may add that some did condemn it. There was no hope, no thought entertained by us that anything practical would come of it. But lo! one day it appeared that one of the substances discovered in the course of the investigation is the sweetest thing on earth; and then it was shown that it can be taken into the system without injury; and finally, that it can be manufactured at such a price as to furnish sweetness at a cheaper rate than it is furnished by the sugar cane or the beet. And soon a great demand for it was created, and to-day it is manufactured in surprising quantities and used extensively in all corners of the globe. Thousands have found employment in the factories in which it is now made, and it appears that in some European countries the new substance has become the sweetening agent of the poor, it being sold in solution by the drop.

It is unnecessary here to discuss the question naturally suggested by the facts just spoken of, whether the discovery of the sweet substance has benefited the human race. It would be extremely difficult, if not impossible, to answer this question. But whatever the answer, it is clear from what has been said that the discovery was of importance from the practical point of view, and there was nothing originally in the work to suggest the possibility of a practical result in the sense in which the word practical is commonly employed.

This is the lesson that we learn over and over again as we study the great industries.

Rarely have they been the results of work undertaken with the object of attaining the practical. Look at the beginnings of electricity. A piece of amber when rubbed attracts bits of pith. A frog's leg twitches after death when touched in certain ways with metals. That was all. Are such things worth investigating? No doubt the practical man said: 'No; stop trifling: do something worth doing.' And if he had been permitted to have his way, all the wonderful results that depend upon the applications of electricity would have been impossible. In every line, much study, much work, and much investigation are absolutely necessary before enough knowledge can be got together to make profitable, practical applications possible. During this early preparatory stage the work is of no direct interest to the purely practical man; and yet without this work the applications which he values would be impossible. Scientific work in its highest form does not pay directly. Those who devote themselves to the pursuit of pure science do not, as a rule, reap pecuniary reward. They probably enjoy their lives as much as if they did, though it is often difficult to make them believe this. But because it does not yield immediate reward to the worker, should the work stop? Surely not. Our only hope of progress in intellectual as well as practical matters lies in a continuation of this work. And even though not a single tangible, practical result should be reached, the work would be valuable. Why? Because we are all helped by knowledge. The more we know of the universe the better fitted we are to fill our places in the world. All will concede the truth of that proposition. But if this is true we have the strongest argument for scientific work, for it is only through such work that we are enlarging our knowledge. There is no other way of learning. Somebody must be adding to our stock of knowledge, or what we call progress in intellectual and material things would stop. It also seems probable that moral progress is aided by intellectual progress, though it might be difficult to make this perfectly clear. I believe it is so; though of course it does not follow that every individual furnishes evidence of the relation between intellectual and moral progress.

But, my friends, whether we will or not, scientific investigation will go on as it has been going on from the earliest times, and it will go on more and more rapidly with time. The universe is inexhaustible, and its mysteries are inexplicable. We may and must strive to learn all we can, but we can not hope to learn all. We are finite; the mysteries we are dealing with are infinite.

IRA REMSEN.

HIGHER EDUCATION IN GERMANY AND THE UNITED STATES.

AN article on 'Thirty Years' Growth of German Universities,' which recently appeared in one of the educational magazines, suggests an investigation along similar lines with reference to our own country and a comparison of existing conditions. There can be no doubt of the fact that there is manifested in this country an increasing purpose to lead the intellectual or the scientific life, which will inevitably tend to raise the standard of American civilization and culture. The growth of our leading universities within the past decade bears eloquent testimony to this fact, and we have no reason to be dissatisfied with the progress that has been made in the field of higher education. A mere glance at the figures in the above-mentioned article describing the growth of the higher institutions of learning in Germany will convey a good idea of the marvelous intellectual advancement of the nation since the Franco-German war. The author shows that, while there had been an increase of 38.9 per cent.

in the male population of Germany between 1870 and 1900, the number of students in attendance at the universities and schools of technology, mining, forestry, agriculture and veterinary science has grown no less than 163.8 per cent., and allowing graduates of these institutions also to enter into his calculations, he finds that in Germany the number of men of university training has doubled within the last thirty years. The total number of university students for 1900 is given as 46,520 and the number of males in the population of the country as 27,731,000, there being thus 16.78 students for every 10,000 males, as against 8.83 thirty years ago.

In attempting to compare the educational conditions represented by these figures with those of the United States, several obstacles are encountered at the very outset. In the first place, American statistics would not be complete and would not constitute a fair criterion of the educational characteristics of our country, were we to exclude from them all women students, for aside from the large enrollment at colleges for women and the great body of women pursuing graduate or professional courses at the universities, it is not at all unusual to find the women in the collegiate departments of our larger universities, especially the state institutions, far outnumbering the men. It is scarcely necessary to state that in contradistinction to this state of affairs, the policy of permitting women to study at the German universities is just beginning to be looked upon here and there with any degree of favor. It would hardly be appropriate to deny woman a place in the intellectual activities of our nation, and we shall, therefore, arrive at a fairer basis of comparison if we take into consideration not only the number of male inhabitants, but the total population of the country. Adopting this basis, we find that in Germany's population of over 56,000,000 there were in 1900 about eight students for every 10,000 inhabitants.

In the second place, it would be manifestly unjust to Germany were we to draw conclusions in regard to the relative participation of the people in higher education in this country and in Germany without first making deductions for the further dissimilarities of conditions that confront us at every turn. The term higher education, as employed in the United States, is a more comprehensive one than it is in Germany, including as it does with us a large number of college students and students in the academic departments of universities who would not be regarded in Germany as university students. Moreover, in Germany every professional student is in reality a graduate student; no one is permitted to matriculate in the faculty of law, medicine, or theology without possessing the *testimonium maturitatis*, the equivalent—in general terms—of our baccalaureate degree, whereas we can boast of only a few institutions that call for a first degree as a prerequisite for admission to any one of these faculties, notably Harvard University for law, medicine and theology, Columbia University for law, and Johns Hopkins University for medicine. It seems reasonable to suppose that at least the more prominent American universities will adopt the higher admission requirements for the professional faculties within the next decade. At all events, even the most strenuous opponents of the theory must admit that the recent growth of the Harvard law school, which can point with pride to an enrollment of over 700 students, is a splendid justification of the lately adopted ideal condition.

Turning from the American professional schools with their inferior requirements to the so-called graduate or post-graduate faculties, we meet with conditions that are

most encouraging, for the number of graduate students in our universities has more than doubled within the past five years. Columbia University alone has almost 700 resident candidates for the higher degrees registered under its graduate faculties of political science, philosophy and pure science, the majority of whom are preparing themselves for the teaching profession. And here we have another encouraging feature of the educational development of our country, viz., the improved facilities for intellectual growth offered to our teachers by means of summer schools, extension courses, public lectures, and similar enterprises conducted under the auspices of our leading universities. At its summer session of 1903 Harvard enrolled almost 1,400 students, and almost 700 students are at present pursuing resident work at the Teachers College of Columbia University, which this year is also giving extension courses to 1,600 students.

Having called attention to the difficulty of making direct comparisons of the growth of higher education in Germany and the United States, let us at least examine some of the salient features of this growth in both countries. Viewed from the standpoint of increase of proportion of students to the entire population, the comparison slightly favors the United States, although the difference is not great, and the advantage would be lost entirely were we to make due allowance for the differences in conceptions discussed above. The following figures will serve to illustrate this point: In 1870 the United States had a population of 38,000,000, which by 1900 had increased to 76,000,000, *i. e.*, it had virtually doubled. In 1872 there were 8.52 students of both sexes in all branches of higher education to each 10,000 inhabitants, whereas in 1900 there were 19.13, somewhat more than twice as many. In Germany the increase between 1870 and 1900 was a little less than double, from 8.83 to 16.78 students for every 10,000 males, the total population of the country having increased from 41,000,000 in 1871 to 56,000,000 in 1900. We must also take into consideration the fact that the United States is growing much more rapidly than the German Empire. In the last decade of the nineteenth century the population of Germany increased 14 per cent., while that of the United States increased almost 21 per cent., and this great increase in the population of our own country is comprised largely of immigrants, of whom only a relatively small proportion is interested in higher education. Another interesting fact is brought out by comparing the actual numerical growth of the student body of the two countries, and employing this basis, the comparison would again favor the United States. Between 1889 and 1900 the total number of students in attendance at the German universities increased 36 per cent., whereas in America between 1890 and 1901 the total increase in the number of undergraduate and resident graduate students in universities, colleges and schools of technology amounted to 86 per cent., and there would be little change in the relative growth were the comparison extended to cover the past thirty years.

One of the most interesting points adduced in the article mentioned is the marked change in the distribution of the students among the different classes of institutions, the figures demonstrating that the schools of technology have since 1892 expanded uninterruptedly and much more rapidly than the general universities. The reason for this expansion is to be sought not so much in the existence of lower entrance requirements for the schools of technology, nor in the circumstance that several schools have been permitted to confer an engineering degree, although both of these factors have some bearing on the development in question. We must go

further to find the true cause. During the past decade Germany has made tremendous advances in the field of industries and manufactures, just as has the United States, and the main reason for the increase in the number of students of technology in both countries—the multiplication of this class of students in our own country during the past decade has been quite marked—is found in the endeavor to supply a demand, the prospective student carefully weighing the chances of earning a livelihood in one field or another. Wherever the supply begins to exceed the demand, a tendency toward reduction is immediately felt, as witness the falling off in the number of medical students in this country and elsewhere during the past year, which in spite of increased standards of admission and other minor causes, must be attributed in the main to the existing superabundance of physicians. In other words, at the present day when the professional schools are making such headway at the expense of the old general culture course, university attendance becomes more and more influenced by existing economic and industrial conditions, especially in a country like the United States, in which the practical side of life is emphasized with such vigor, and likewise in a country such as Germany, which during the past few years has adopted so many of our own methods in the conduct of its industrial and commercial affairs. While Germany can not be said to have sacrificed any educational ideals for this new movement, it has at all events allowed the influence of things practical to be strongly felt. In connection with this important question of the widespread increase of applied science students as affecting both Germany and the United States, we might point out that in no instance does a German school of technology form a coherent part of a university proper, as is so frequently the case in this country. And what is more, it seldom happens that a German technological school is located in a university town, and more than one such school is never, under any circumstance, allowed to exist in the same city, whereas in the United States we revel in the luxury of supporting several technological departments within hailing distance of one another, to mention only Harvard University, the Massachusetts Institute of Technology and Tufts College, for Boston, and Columbia University, the Stevens Institute of Technology and New York University, for New York City, all of which institutions offer courses in applied science.

Nothing furnishes a more vivid illustration of the practical tendencies visible in American education than the existence of departments of commerce and accounts as constituent parts of several of our leading institutions of learning, and the contemplated establishment of a school of journalism in connection with Columbia University is but another phase of this constant and growing endeavor to enlarge the field of legitimate university activity in practical directions.

Summarizing briefly, we have found that both in Germany and in the United States wonderful progress has been made in recent years in the spread of higher education, and this development may be regarded as a specific manifestation of the general material prosperity which has characterized the life of both countries during the past thirty years. The amazing development of the industrial activities of both nations has found a decided reflection in the rapid increase in the enrollments of the schools of technology and the university faculties of applied science, an increase far above the normal and illustrative of the modern striving to bring education into closer and closer accord with the living issues and problems of the day. And no harm will result from this tendency, pro-

vided the proper ideals are never sacrificed to the popular demand, for there seems to be no cogent reason why the intellectual advancement of a nation should not be in perfect harmony with all those things that constitute the sphere of its practical activity. The future of higher education in Germany and in the United States will be proof against all attacks, provided there is no diminution in the proportion of persons animated by a desire to lead the intellectual life, and provided further that we never cease to adhere to those ideals of scholarship and learning which have contributed in such bountiful measure to Germany's commanding position in the educational world.

RUDOLF TOMBO, JR., PH.D.,
Registrar, Columbia University.

SCIENTIFIC BOOKS.

Catalogue of the Ward-Coonley Collection of Meteorites. By HENRY A. WARD, A.M., LL.D. Pp. xii + 113, with 10 plates. Published by the Author. Chicago, May, 1904.

The Ward-Coonley collection of meteorites comprises at the present time representatives of more falls than any other collection in the world. Of about 680 meteorites known, the Ward-Coonley collection contains 603, which is 43 more than the number in the Vienna collection, according to the latest catalogue (1902), and 46 more than the British Museum collection contains, according to its latest catalogue (1904). The attainment of so remarkable a completeness by the Ward-Coonley collection is set forth in the catalogue just published by Professor Ward. The work contains much information of value besides being a catalogue.

In an interesting preface the author describes the manner in which the collection has been built up. Attention is called to the fact that exchange has proved quite as important a means of acquiring meteorites as purchase, and a liberal policy in this regard on the part of museums and collectors who would enlarge their collections is urged. The Gregory and Siemaschko collections are stated to be largely incorporated in the Ward-Coonley collection, while extensive travel by Professor Ward yielded meteorites obtainable in no other way. The first seventy pages of the catalogue are devoted to a list of the meteorites represented in the collection. These are arranged alphabetically under the groups of siderites, siderolites and aerolites. The list gives the name of the meteorite preferred by the author, its classification according to Brezina's system, the latitude and longitude of the locality and a statement of the locality according to political divisions. Reference to the first description of the meteorite is then given and the weight in grams of the chief piece and total weight in the Ward-Coonley collection. It is evident that great care has been taken to render this part of the catalogue accurate in detail, and the large amount of painstaking labor necessary to achieve this result can be appreciated only by those who have essayed similar tasks. So thoroughly has the work been done, however, that this catalogue may be considered the most authoritative work now extant in regard to the names and localities of the meteorites which it lists. American locality names of meteorites in particular have suffered so wofully from the mistakes of foreign authorities hitherto that it is cause for congratulation that the matter has been taken in hand by one so familiar with the subject as Professor Ward.

Following the list of specimens in the Ward-Coonley collection, an alphabetical list of all known meteorites is given with such synonyms as have importance. Here again the wide experience and knowledge of the author give the list a peculiar value. It has not been burdened with synonyms resulting from imperfect or careless spelling, but genuine synonyms have been retained.

The next division of the catalogue shows the geographical distribution of all known meteorites according to countries. The meteorites of each country are arranged alphabetically under that division and their date of fall or find, and classification as iron or stone shown. Division VI. of the catalogue has been contributed by Dr. Brezina, of Vienna.

This gives in complete form the classification of meteorites wrought out by Dr. Brezina at the Vienna Museum and now brought quite up to date. Seventy-four groups are named and under each group are given the meteorites assigned to each. The complete presentation of this classification is a work which will be of great service to students of meteorites and an aid to further study of the groups. Following this a table shows to what extent these groups are represented in the Ward-Coonley collection. It appears that all the groups are represented and 95 per cent. of the group localities. The total weight of the collection is given as 2,495 kilos (5,509 pounds), and the total number of specimens as about 1,600. The average weight of the representatives of each fall is 4,138 grams (9⅛ pounds), or, counting nothing over 50 kilograms to a fall, 1,746 grams (3⅞ pounds).

The following meteorites are stated to have larger representatives in the Ward-Coonley collection than in any other: Among siderites, Arispe, Bacubirito, Ballinoo, Cañon Diablo, Canyon City, Central Missouri, Costilla Peak, Illinois Gulch, Luis Lopez, Nejed, Roebourne, Saint Genevieve, Surprise Springs, Tonganoxie, Ute Pass and Willamette. Among siderolites, Morristown, Pavlodar and Veramin. Among aerolites, Baratta, Bluff, Castine, Indarch, MacKinney, Mighei, Ness County, Oakley, Petersburg, Pipe Creek and Rushville.

Adjuncts to the collection such as casts, micro-sections, betyl coins, etc., are listed and the ten illustrative full-page plates show the appearance of about fifty typical specimens of the collection and the manner of mounting and installation.

It is a cause for felicitation that so large and complete a collection of meteorites is to be found on this side of the Atlantic, and students of science will join with Dr. Brezina in congratulating, as he does in a recent letter which the present writer has been permitted to see, Professor Ward 'upon the results of such uncommon energy and experience. Instead of three first-class world collections, Vienna, London and Paris,' says Dr. Brezina, 'there exist now four.'

Oliver C. Farrington.

Le Mouvement. By R. S. Woodworth. Paris, O. Doin. 1903. Pp. viii + 421. 4 fr.

This volume, which is a part of the 'Bibliothèque internationale de psychologie expérimentale normale et pathologique,' edited by Dr. Toulouse, is an excellent and complete discussion of movement in all its aspects.

The work is divided into two parts, viz., I., on the perception of bodily movements, and II., on the production of movement.

In the first part there are excellent accounts of the physiological, clinical and anatomical findings regarding the muscular sense, and of the functions of the semi-circular canals in relation to sensations of movement. The remainder of the section is concerned with a general survey of the literature on the perception of the extent, the time, and the force of movement, on the perception of lifted weights, on weight illusions, and a critique of Weber's law in relation to the perception of movement.

The second part—on the production of movement—consists in discussions regarding reflex action, coordination, dynamogenesis, motor automatism, voluntary movement, rapidity of voluntary movement—including reaction time—the precision of movement, and fatigue.

Not every one will agree with the author regarding the rôle of the synapses in the production of habits, etc. (p. 227): "S'il y a un arrêt quelconque dans le système nerveux, comme cela arrive pendant le sommeil, il provient probablement du synapse. Et probablement aussi, c'est le dévelopement des extrémités nerveuses et le rapprochement des extrémités des branches de dendrites et de l'axe qui produisent la formation des habitudes et la maturité des instincts." The movements of dendrites and the shortening of spaces between parts of contiguous neurons has not been sufficiently investigated to make the above statement 'probable.'

Fatigue is considered to be a phenomenon connected with muscle, very little or not at all with the neurons controlling the muscle. This view, it is admitted, is somewhat radical, but the author guardedly concludes that 'the theory of the participation of the central nervous system in motor fatigue is without proof' (p. 400). It might also be retorted

that the theory of muscle being the only seat of so-called motor fatigue is yet without proof. The early experiments of Mosso and of other investigators do not clearly establish a nervous fatigue, but results in these, and certain later experiments may be explained in either way, namely, that there is nervous fatigue or that there is only muscular fatigue. There is, indeed, as much reason to say that there is a widening of the synapses in fatigue as in sleep (see above).

Such a book has long been needed both by psychologists and by physiologists. Material has been carefully chosen from psychological, physiological and clinical literature, and theory has been properly subordinated to fact.

SHEPHERD IVORY FRANZ.

McLEAN HOSPITAL,
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SOCIETIES AND ACADEMIES.

SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE seventh regular meeting of the society was held on Wednesday, May 18, at 8:30 P.M., in the physiological laboratory of the New York University and Bellevue Hospital Medical College at 338 East 26th Street. Dr. S. J. Meltzer presided.

Members present. — Adler, Burton-Opitz, Dunham, Ewing, Gies, Jackson, Levene, Lusk, Meltzer, Murlin, Richards, Salant, Wadsworth, Wallace, Yatsu.

Members elected.—P. B. Hawk, W. G. MacCallum, A. R. Mandel, R. M. Pearce, Franz Pfaff, William Salant, H. U. Williams, A. S. Warthin.

ABSTRACT OF REPORTS ON ORIGINAL INVESTIGATIONS.*

The Lecithin Content of Fatty Extracts from the Kidney (Preliminary Report): E. K. DUNHAM.

Rosenfeld has shown that the percentage of the alcohol-chloroform extracts from the dried kidneys of dogs, both normal and 'fatty,' fluctuates within very narrow limits. He calls these extracts 'fat,' and regards the microscopical examination as entirely untrustworthy for gauging the amount of fat in the kidney. His work on other organs has led him to the conclusion that, when the fat content is increased in the cells, it has been transported from the fat-depots of the body. It appeared to the author of interest to compare the extracts obtained from the kidney by Rosenfeld's method with similar extracts from the depot-fats. It was at once evident that they differed markedly in the percentage of phosphorus they contained, as is shown by the following analytic results.

Alcohol-chloroform Extracts.	Percentage of Phosphorus.
Human kidney (mean of 28 analyses)	1.3849
Panniculus adiposus (4 2288 grams)	0.0026
Perinephritic fat (5.6750 grams)	0.0069

The extract from the kidney contains from 200 to 500 times as much phosphorus as the extract from depot-fat. These facts suffice to show that the two extracts are not directly comparable, and to throw doubt upon the idea advanced by Rosenfeld that the fat in 'fatty' organs is a simple infiltration from the depots of the body.

The phosphorus in these extracts was found to be wholly organic in character. Protagon could not be detected even in 400 grams of the tissue. The quantity of jecorin that may have been present was too small to influence materially the analytical results. The most probable compounds containing the phosphorus are forms of lecithin. The barium hydroxide-platinic chloride method for the separation of cholin was employed with the following results:

	Extract, Grams.	Phosphorus, per cent.	Platinum, Gram.	Licithin in the Extract (Calculated as Di-stearyl-lecithin), per cent.
I.	0.4600	1.43	—	37.23
	0.4600	1.47	—	37.45
	1.5859	—	0.0650	34.50
II	0.6032	1.12	—	29.11
	0.6032	1.11	—	28.99
	2.1556	—	0.0711	27.40

Before incineration, in the first case, the platinum salt in the crucible weighed 0.2009

* The authors of the reports have furnished the abstracts. The secretary has made only a few abbreviations and minor alterations in them.

gram. The platinum, therefore, constituted 32.7 per cent. of the salt. Cholin platinic chloride contains 31.6 per cent. of platinum. It appears highly probable, however, that some of the platinum salt was decomposed during the concentration of its solution with heat. It is also possible that some of the cholin suffered decomposition, or was lost, in the manipulations preceding its precipitation with platinic chloride. With these considerations in mind, the foregoing results render it highly probable that the phosphorus is present in some form of licithin, but although these calculations are based on di-stearyl-lecithin, it is certain that this is not the only lecithin present. The fact that lecithin obtained in moderate purity (about 99 per cent.) from the kidney extract promptly blackens with osmic acid, indicates that the oleic acid radicle is present. The recognition of this fact would make but trifling changes in the calculations in this report.

The foregoing analyses appear to justify the conclusion that one may, at least tentatively, assume the phosphorus content of the extracts obtained to be dependent upon the presence of some form of lecithin.

Upon this assumption the calculations given in the following table* are based:

	Extract, % of Dry Organ.	Phosphorus, % of the Extract.	Lecithin, % of the Extract.	Lecithin, % of Dry Organ.	Autopsy Report. Cause of Death.	Weight of Kidney.
			Human Kidneys.			Grams.
I.	11.42	2.11	55.07	6.29	Pneumonia and hepatic abscesses.	200
	12.48	2.00	52.03	6.49		
II.	11.44	1.35	35.14	4.02	Tuberculosis.	200
XI.	15.40	1.18	30.84	4.76	Moderately fatty kidneys.	——
	15.51	1.19	31.09	4.80		
			Beef Kidneys.			
II.	15.02	2.10	54.64	8.21	——	——
			Dog Kidneys.			
I.	14.93	2.04	53.29	7.95	——	——
			Rabbit Kidneys.			
I.	16.59	2.53	66.06	10.96 †	——	——

* The author presented a large number of data. The table here given shows only a few examples of the many results obtained.

† 2.24 per cent. of the fresh kidney.

These analyses demonstrate that even in the kidney, which can not be regarded as one of the fat-depots of the body and which probably plays little, if any, part in the general fat metabolism, the lecithin content must be taken into consideration in any study of the fatty extract. The limited number of the observations here referred to do not justify conclusions bearing upon the question of the nature of the fatty changes met with in the kidney, but it is the author's intention to continue the study of this subject.

On the Phloridzin Test in Bright's Disease: P. A. Levene and L. B. Stookey.

Investigation of the action of phloridzin in Bright's disease has a theoretical as well as a practical interest. The mechanism of kidney diabetes is as yet imperfectly understood. The original idea that it was due to a change in the permeability of the kidney epithelium has gradually lost support, and instead there is a growing belief in the hypothesis that, in kidney diabetes, the sugar owes its origin to an exaggerated catabolic condition of the kidney. This view was first expressed by one of the authors in 1894. In support of this theory evidence was brought forward to show that in animals with injured kidneys, phloridzin fails to bring about glycosuria, or causes it in less degree than in normal animals. However, it is impossible to injure, by means of drugs or by mechanical interference, only one special part of the kidney. In the course of Bright's disease there are known conditions under which the involvement of either the epithelium or of the glomeruli predominates to a very great extent, and this, of course, enables one to study the seat of the sugar formation within the kidney. The observations of most authors tend to show that when the epithelium of the kidney is injured administration of phloridzin fails to cause glycosuria or does so in very slight degree.

The authors injected simultaneously phloridzin and methylene blue, and compared the course of the elimination of the dye with that of the sugar. The results of their observations in a general way corroborate the statements made by other writers. In acute parenchymatous Bright's disease sugar fails to

appear in the urine after the administration of phloridzin. In chronic forms of the disease, when only a trace of albumen can be detected in the urine, and when the permeability of the kidney for methylene blue is normal, there is frequently a diminished sugar elimination—diminished as compared with that in health under the influence of phloridzin. In no case was there observed an impaired permeability for methylene blue with a normal sugar elimination, but the contrary was often the case.

Levene's modification of Allihus's method was used for the sugar determinations. Further work in this direction is in progress.

Effect of Blood Serum in Pneumonia upon the Heart (Preliminary Report): ISAAC ADLER and RICHARD WEIL.

The object of these experiments was to determine whether blood serum in pneumonia has a specific effect upon the heart and, also, whether there is any difference in action between the serum taken *before* and the serum obtained *after* the crisis. The experiments were made upon the heart of the turtle, use of the mammalian heart being impracticable, in this connection, for many reasons. The fluids to be tested entered the heart through a glass cannula introduced through the right aorta into the corresponding ventricle, passed through the septum into the left ventricle and flowed out through a cannula in the left aorta. Care was taken to keep the temperature, concentration and hydrostatic pressure uniformly constant. The veins were all carefully ligated. The small diaphragmatic vein at the apex was tied and cut, the ligature connected with a writing lever, and the contractions of the heart thus recorded upon a drum.

Normal human serum acts upon the heart of the turtle as a violent inhibitor, but it was found that in a dilution of 1–20, or better still, 1–15, it does not differ greatly in effect from 'normal saline.' All sera were thereupon tested in dilution of 1–20 or 1–15, and the routine of each experiment as ultimately adopted was as follows: Infusion into the heart, (*a*) 'normal saline,' (*b*) normal blood serum, (*c*) 'normal saline,' (*d*) serum *before* crisis, (*e*) 'normal saline,' (*f*) serum *after* crisis. In this manner after considerable preliminary experimentation very characteristic tracings were obtained.

Two cases of lobar pneumonia and one case of broncho pneumonia have thus far been studied. The tracings obtained were demonstrated and it appeared from them that the serum in pneumonia before the crisis, at least in the cases tested, acted upon the heart of the turtle as a most violent poison. The contractions at once became extremely weak and slow and the pauses very long. The serum taken after the crisis gave tracings not very materially different from those obtained with normal serum.

The Influence of Alcohol on Biliary Secretion: WILLIAM SALANT.

In the author's experiments, fasting or well fed dogs were the subjects. Operation and collection were conducted in the usual manner. Ether narcosis was employed in every instance without previous injection of morphine. The rate of secretion was studied by comparing the amounts collected during periods of fifteen minutes. The rate of secretion during the first four or five periods was used as a control, at the end of which time alcohol was injected by means of a burette into the femoral vein. Varying strengths of alcohol were used, four and one half per cent., thirty per cent. and sixty per cent. The quantities administered were usually about 4 c.c. per kilo of body weight.

After the injection of alcohol it was found in all cases that the secretion of bile continued to diminish, the diminution in the rate of secretion being, however, somewhat greater than in the two or three control periods immediately preceding the administration of alcohol. Since the much larger quantity of bile of the first and second periods probably represents bile that has been held back during the operation, it could not be considered as a control. The author, therefore, regarded as a control the rate of secretion during the following two or three periods. Whether this slightly diminished secretion is to be ascribed to the influence of alcohol can only be decided by further comparisons of the rate of secretion in alcoholized and normal animals. Thus, in

three dogs without alcohol the rate of secretion corresponding to the alcohol periods was as follows: A decline during the fourth, fifth and sixth periods, succeeded by a rise in the next period. In the second experiment the rate of secretion remained practically steady during the fifth, sixth, seventh and eighth periods. In the third experiment there was a variation, but the average rate of secretion was about the same in the fifth, sixth and seventh periods as in the preceding two experiments. It would seem, therefore, that the diminished secretion following intravenous injection of alcohol might be due to the effect of alcohol.

A study of the effect of alcohol on biliary secretion after injection into the stomach was also begun. It would seem *a priori*, in the light of recent investigations by Bayliss and Starling, Fleig and Henriot, on the relation of secretin to the secretion of bile, that the author's method of administering alcohol ought to provoke secretion of bile. In the few experiments the author has made thus far he has observed that when sixty per cent. alcohol was introduced into the stomach there was a slight, transitory increase of biliary secretion. With thirty per cent. alcohol there was in some cases an increase, in some a decrease, of the secretion of bile as compared with prealcoholic periods. At this stage of the work it would be premature to form any conclusion regarding this point. Whether this slight increase is due to increased gastric secretion and consequent formation of secretin, or is reflex in nature, will next be investigated.

The Influence of Repeated External Hemorrhages on the General Composition of the Blood. G. M. Meyer and W. J. Gies.

Various observers have noted the fact that the composition of the blood changes after hemorrhage, but no systematic study has been made of these modifications. The authors have begun such an investigation for the purpose of establishing a more definite basis for comparative blood analysis. They reported the results of their observations on posthemorrhagic changes in the percentage content of water, total solids, organic solids and ash. Further study is in progress.

Healthy, well nourished or fasting dogs, in light morphia-atropin narcosis were used and quantities of blood ranging from 0.2 to 1.0 per cent. of body weight were taken. These amounts were drawn from the femoral artery and approximately the same quantity was taken in each experiment at regular intervals, varying from fifteen minutes to two hours, until death ensued. In one experiment a continuous fatal hemorrhage was effected and the blood analyzed in portions. Thus far twenty experiments have been carried out. In some of them the serum was also analyzed.

The following conclusions were reported: Hemorrhage causes increase of water and decrease of solids in the remaining blood. *Hemorrhages of about 0.6 per cent. of body weight* cause little or no change in general composition of the blood until after 2.5 per cent. has been taken. Under the conditions of these experiments it was generally found that the longer the intervals between withdrawals the less the maximal differences between composition of the first and last fractions. Short intervals between bleedings, all other conditions being equal, favored the largest total withdrawals before death ensued.

The differences in the serum ran parallel with those in the blood, but were less marked. The ash did not vary very much in either the blood or the serum, no matter how much blood was taken. The blood ash and that from the serum were practically the same in relative amount, though different in composition.

When *small* quantities of blood *equal to about 0.2 per cent. of body weight* were removed at intervals of about a half-hour, little change was noted in either blood or serum until after 3 per cent. had been taken. After this quantity had been lost the changes following further hemorrhage were such as usually occur. The maximum differences in percentage composition of the first and last fractions varied somewhat. The differences in the amounts of solids, for example, ranged from 1.5 to 3.5 per cent.

In *fasting animals* the influence of hemorrhage on chemical change in the remaining blood was somewhat more marked than in well

nourished ones. The effect on the serum was about the same.

Other influences in the experiments were carefully controlled. The observed effects were due only in slight degree to the narcotics and the conditions attending the operations.

Demonstration of a New Portable Sphygmomanometer: T. C. JANEWAY.

Dr. Janeway's instrument was designed with the object of securing a thoroughly portable clinical sphygmomanometer, in which nothing essential to accuracy should be sacrificed. It employs the method of circular compression of Riva-Rocci, and Hill, with the 12cm. width of armlet proved necessary by Von Recklinghausen. The special construction of the cuff allows of adaptation to arms from 15 to 34 cm. in circumference. The original feature of the instrument is the folding U-tube manometer. This is a jointed U-tube manometer (copied from Cook), fastened to the under surface of the box-lid, so arranged that, when closed for carrying, it measures 10¼ x 4⅝ x 1⅞ inches, and with armlet and inflator weighs 2½ pounds. The manometer is perfectly secure when closed and stands firmly when open. The tube-caliber is 3 mm. The sliding scale is empirically graduated for each instrument, to compensate for variation in the glass tubing, and is accurate. All connections are of heavy pressure tubing. For inflation a Politzer bag is used, as by Erlanger, except that one with valve is necessary to fill the large armlet. The gradual release of pressure is provided for by a stop-cock, with needle-valve of special construction, the work of Mr. Charles E. Dressler, who is making the sphygmomanometer for sale.

The method of use, as of the other modern sphygmomanometers, is based on the criterion of the return of the pulse after obliteration (Vierordt), for systolic pressure, and is similar to the Riva-Rocci and its modifications. A fair approximation of diastolic pressure may also be obtained in most cases, using the criterion of maximum pulsation (Marey, Mosso). This is especially useful in cases of aortic insufficiency, or marked hypertension. For experimental work upon the systolic and diastolic pressures, it can not compare with Erlanger's more elaborate and costly instrument, but aims to serve the clinician by providing him with an accurate yet not bulky or costly instrument, for general use. Stanton's sphygmomanometer, which appeared after this one had been begun, answers the same purposes. The only criticism to be made of it is, that 8 cm. width of armpiece does not afford a guarantee of complete accuracy on large arms.

Demonstration of Cytological Preparations: NAOHIDÉ YATSU.

Mr. Yatsu exhibited seven preparations demonstrating important cytological structures found both in eggs normally fertilized and in some treated chemically. He spoke on the achromatic figure in mitosis, with special reference to the morphology and cycle of the centrosome.

Preparation I. Metaphase of the first polar mitosis with two centrioles at each pole (egg of *Cerebratulus*).

Preparation II. Sperm nucleus with sperm aster, in which each daughter centriole has acquired a new system of rays (egg of *Cerebratulus*).

Preparation III. Anaphase of the first cleavage mitosis, showing two centrioles in each centrosome (egg of *Cerebratulus*).

Preparation IV. Telophase of the first cleavage mitosis, showing typical centrosomes (egg of *Ascaris*, Professor Wilson's preparation).

Preparation V. Mitosis without chromosomes in a late blastula (egg of *Asterias*, unfertilized and etherized). In one of the blastomeres the aster is dividing, forming a typical central spindle but devoid of chromosomes.

Preparation VI. Cytasters (egg of *Asterias*, unfertilized and etherized). Many cytasters are found in the cytoplasm, some dividing, some forming synthetic triasters.

Preparation VII. Cytasters (egg of *Cerebratulus*, unfertilized and treated with a solution of calcium chloride). Many cytasters have appeared, the first polar mitosis being disturbed.

The Influence of Subcutaneous Injections, and of Instillations, of Adrenalin upon the Pupils of Frogs, with Demonstrations: S. J. Meltzer and Clara Meltzer Auer.

Many observers have established the fact that subcutaneous injections as well as instillations of adrenalin exert no influence upon the width of the pupil in normal mammals. In a series of experiments published recently by the authors of this report it was shown that from 24 to 48 hours after the removal of the superior cervical ganglion a subcutaneous injection or an instillation of adrenalin caused a considerable dilation of the pupil, which lasted an hour or longer.

In the present communication the authors report that in frogs a subcutaneous injection or an instillation of adrenalin into the conjunctival sac causes an unmistakable dilation of the pupils of a normal animal. The dilation lasts a good deal longer than was ever observed in mammals even after removal of the ganglion; after instillation some dilation may be perceptible as long as 36 hours. The maximum dilation may even continue as long as 12 hours.

When the cord is severed just below the medulla oblongata, the pupils usually become small and ellipsoid in shape. A subcutaneous injection causes them to become wide and round. Instillation has the same effect. Finally the effect of instillation can be well observed also on the excised eyes, even when the adrenalin is applied some hours after excision, provided the eyes are kept moist. The experiments were demonstrated.

William J. Gies,
Secretary.

THE TORREY BOTANICAL CLUB.

The meeting of April 12, 1904, was held at the New York College of Pharmacy, with Dr. MacDougal in the chair.

The first paper of the evening was by Professor L. M. Underwood on '*Cyathea* and its Allies in Jamaica.' One of the objects of Professor Underwood's trip to Jamaica last year was to study the tree ferns in the field. Specimens usually show a single pinna without its connections or any part of the caudex. Such material has been used for types and one species has been described from a single pinnule. Although a species which is well known can often be recognized by a fragment of a good specimen, it should show as much as possible of a pinna, its connection with the main rachis, and part of the caudex.

The Cyatheaceæ or tree ferns mostly have an elongated caudex or trunk, but a few are herbaceous. The more distinctive family characters are furnished by the sporangia, which are rounded-triangular with complete ring and are sessile or very shortly stalked. There are six genera in the West Indies distinguished by the character of the indusium, habit and cutting of the leaves.

Cyathea arborea is the oldest and best known of the West Indian tree ferns and the only one common to most of the islands, many of the species being found only on the islands on which they were originally described. It occurs at an elevation of 1,000 to 2,000 feet and forms a handsome tree with a spread of 14 to 18 feet. Above this it is replaced by a similar but larger species of *Alsophila*. *Cyathea arborea* and *C. elegans* are noticeably distinguishable by the caudex, that of the former being smooth, while that of the latter is very rough and shaggy. *C. nigrescens* is common to Jamaica and Cuba. *C. insignis* is a handsome plant, but as only two were seen, and these represented perhaps 200 years' growth, they were not taken for specimens, but notes were made on the trunk characters. A fine specimen is in cultivation at the conservatory of the Botanical Garden brought up by Professor Earle. Of the sixteen species of *Cyathea* which are not doubtful, thirteen are endemic in Jamaica and three are known only from type specimens. The sharp prickles of these and other species secrete a poison and wounds from them are very painful, so that collecting on the steep hillsides is likely to be attended with considerable discomfort. The genus *Alsophila* has three species which are well known. *A. armata,* occurring at 4,000 to 5,000 feet elevation, has a usual height of 40 to 45 feet and is the most graceful plant of the island. It is armed only with weak bristles. *Alsophila aspera,* which is a lower

tree, has smooth leaves but prickly petioles. It occurs at about 1,500 feet elevation. Two of the species are endemic. *Hemitelia* has one species, described early in the last century, which is probably extinct, and two others very little known. A species of *Lophosoria* has a dense bloom on the under side of the leaves and is somewhat xerophytic in habit. It has merely a woody base.

Cnemidaria is distinguished by its habit and the cutting of its leaves. It has veins uniting near the midrib to form meshes.

Amphidesmium, from Trinidad and South America, differs from all other ferns in that the veins bear a second or even third sorus.

Most of the species discussed were illustrated by herbarium specimens and by portions of their trunks.

The second paper was by Dr. P. A. Rydberg, on 'The Flora of Northwest America.' A general discussion of the manuals available for the identification of the plants of different parts of the United States was given and a review of Mr. Howell's flora of the Columbia River region.

WILLIAM T. HORNE,
Secretary pro tem.

THE PSYCHOLOGICAL CLUB OF CORNELL UNIVERSITY.

THE session of 1904 has been devoted to the consideration of current theories of auditory sensation. The following papers have been read:

MR. H. C. STEVENS: 'The Helmholtz Theory.'

DR. J. W. BAIRD: 'The Facts of Auditory Sensation.'

MR. C. E. FERREE: 'The Physics of the Ear.'

MR. C. E. GALLOWAY: 'The Histology of the Ear.'

MR. C. E. GALLOWAY: 'The Physiology of the Ear.'

PROFESSOR E. B. TITCHENER: 'Rutherford's Theory and its Relation to the Helmholtz Theory.'

PROFESSOR I. M. BENTLEY: 'Ebbinghaus and Stumpf.'

MR. G. H. SABINE: 'Max Meyer.'

DR. T. DE LAGUNA: 'Ter Kuile's Theory.'

MISS A. JENKINS: 'Ayers's Theory.'

PROFESSOR TITCHENER: 'The Theories of Gray and Wundt.'

MISS E. MURRAY: 'Hermann and Ewald.'

MR. STEVENS: 'Objections to the Helmholtz Theory.'

PROFESSOR BENTLEY: 'Is Analysis Possible without Resonators?'

DISCUSSION AND CORRESPONDENCE.

KINDERGARTEN SCIENCE.

DR. THEODORE GILL'S arraignment in SCIENCE (No. 488) of popular writers on natural history who indulge in 'baby talk,' by which is meant the practise of 'talking down' to an assumed inferior level of understanding, is a point exceedingly well taken. The use of a 'trot' to enable the young idea to canter smoothly along the road to learning, and thus avoid the toilsome march, is as much to be deprecated in natural science as in classics or other studies.

Dr. Gill's censure happens in this instance to be directed against over-popularizers of paleontology, whose administration of sugar-coated tabloids to juvenile readers is objected to on the ground, as he puts it, that 'science is scarcely food for babies.' But paleontological writers are not the only offenders in this direction. For the employment of kindergarten methods of illustration, even in serious articles, no science can compare with physiography. The recent literature of this subject has been suffering from a mania for interpreting topographic features in terms of vital phenomena, and for correlating, or attempting to correlate, physical changes (*cycle* is a misnomer) with stages of organic development. *Youth, maturity* and *old age* are terms constantly employed for indicating the successive expressions of unchanging forces in nature, for things as essentially different from life as the growth of the crystal is different from the growth of the individual.

It may be answered that an analogy is not implied by the use of these terms in a figurative sense, or if one is suggested, it is not harmful. Harmful it does become, however, when a false analogy is strained so far as to produce senseless or even ludicrous incongruities. Without exaggerating the prevailing style of metaphor, it may be said that a coordinate value is placed by physiographers upon the ridges and valleys of landscapes, and

the like-named structures in horses' teeth. They profess ability to examine a river's mouth and tell as shrewdly as any veterinarian whether the animated stream belongs to the colt stage, the four-year-old, or the decrepit old equine condition. To the discerning eye even pathologic conditions are revealed, for has not one writer described a stream with 'blind staggers'? Let any one cast a glance over the recent literature, if one suspects the simile overdone, and note, amongst other things, the surprising array of anthropomorphic conceptions of nature. Take even a master-craftsman like Professor Davis, originator, if I mistake not, of the terms 'pirate stream,' 'captured tributaries,' 'drowned valleys,' etc. (the hybrid 'peneplain' belongs to another story)—has he not said of Greece that it 'is a country standing up to its knees in the Mediterranean'? The fact may be literally true, but it is hardly decorous to specify anatomical particulars.

Another writer who believes in the virtue of parables characterizes a rapidly eroded land-surface as a 'precocious infant,' from which the lay reader may surmise that it has just graduated from kilts. But for delightfully refreshing imagery we must refer to a short article on 'The Aggrading Bar,' which appeared in these columns some little time ago (Science, V., p. 646), and begins as follows:

> "The little wriggling bar staggering blindly along in a broad meandering valley is like a small boy attempting to fill his grandfather's boots. The waste supplied from the side of the hills of the adolescent valley, cut by the ancestor of the present stream, is much too great a load for a little brook."

Here the anthropomorphic suggestion is very skilfully rendered, in fact so realistically that the fate of this inebriate little brook, after taking on its load at the aggrading bar, might almost be said 'to point a moral or adorn a tale.' As class-room illustrations, or as intending to impart instruction by means of allegory, figurative descriptions of this nature may, perhaps, be tolerated, but it is gratuitous to suppose that the method of Æsop is better adapted to the needs of readers of Science than the method of Zadig. Sully Prudhomme, in his essay 'On the Nature of Things,' makes some pointed remarks on the habit personifying inanimate nature, which it may be well for physiographers to take to heart.

Other illustrations of the kindergarten method might be given, but it is probably unnecessary to prove that the standard of most of our popular scientific magazines has become lowered through the habit of 'talking down' to average readers, instead of raised by talking just a little over their heads. Let it be asked as a general question which style of writing is the more helpful to students, that which assumes too much on their part, or too little? Does not there come a time in the education of youth when suggestion by means of nursery methods ceases to be a virtue? When a student reaches the point where he may be expected to dig for himself, let us put a spade into his hand, taking care, however, to call it a spade, and not a toy for making mud-pies.

C. R. Eastman.
Harvard University.

'Vegetable Balls.'

Regarding the subject of 'Vegetable Balls' the following additional information may be worthy of note. This curious formation is characteristic of the section Ægagropila of the genus *Cladophora* and is mentioned in Engler and Prantl's 'Die Naturlichen Pflanzenfamilien,' De Ionis 'Sylloge Algarum' and Hanck's 'Meeresalgen.' The most recent work on the subject seems to be that of C. Wesenberg on *Ægagropila Sauteri* (Overs. k. dansk. Vidensk. Selsk. Forh., II., 1903, pp. 168–203), of which there is a very good summary in *Jour. Roy. Micr. Soc.*, April, 1904. The alga occurs in Lake Sorö, Denmark, and the balls attain the size of the fist or of a child's head.

J. Adams.
Royal College of Science, Dublin,
June 29, 1904.

A Notable Paleobotanical Discovery.

To the Editor of Science: Inasmuch as a note by the undersigned, entitled 'A Notable Paleobotanical Discovery,' in Science of July 8, was delayed in publication it is only just

to the writer to state that the article in question was written last January, before the final results of Professors Oliver and Scott had reached me, and that the footnotes which called attention to the later discoveries were added in April, when I read the proof.

With regard to the statement in the opening paragraph that the term Cycadofilicales was destined to become a permanent acquisition to taxonomy, I had in mind rather the idea that botanists would henceforward be unable to dispute the existence of paleozoic plants intermediate between the Pteridophyta and the Gymnosperms, rather than the question of terminology, and hence did not notice this slip of expression in a paper which further on mentions a new and vastly more appropriate name for the group in question.

EDWARD W. BERRY.

PASSAIC, N. J.

SPECIAL ARTICLES.

EVOLUTION AND PHYSICS.

EMINENT British biologists have recently visited severe criticisms* upon Lord Kelvin for giving voice to the opinion that evolution lies beyond the borders of physics and chemistry. The zeal with which they have hastened to the defense of current mechanical hypotheses of evolution apparently causes them to forget that it is exactly these physical conceptions with which Lord Kelvin may be supposed to be qualified to deal. And when Lord Kelvin admits that the 'forces,' 'principles,' 'energies' or other abstractions in use among physicists are not adequate for even a formal explanation of such biological phenomena as evolution, he states what is well-nigh axiomatic to some, and reaches a point of view appreciated by rapidly increasing numbers of biologists.†

The idea that there are biological phenomena essentially different from those of physics and chemistry has nothing to do with the theory of 'vital force' of half a century ago. It does not overlook the vast amount of physics and chemistry already found in plants and animals, nor the probability that multitudes of similar facts remain to be discovered. To argue, however, from the progress of knowledge in these directions that all the phenomena of organic existence are to be explained in current physical terms is to imitate the balloonist who reasoned that he would be able to see all the way around the earth if he could only go high enough.

It is entirely possible, of course, to range organic evolution under chemistry or physics, but at present it seems not to assort well with the other phenomena treated in these sciences. The difference appears to be, furthermore, not merely one of degree, but of kind, so that it may well be asked whether it is not more scientific for Lord Kelvin to recognize and admit such a distinction, even though it may prove ultimately to have rested on a present limitation of knowledge, than for his critics to insist on the identity of phenomena between which no indication of relationship has been shown. At least we must expect that the unprejudiced layman will think it quite as possible that the biologists have been indulging in bad physics as that Lord Kelvin is totally in error with regard to the rôle of physical forces in biology. The outsider might even wonder why the eminent specialists from the two branches of knowledge are not organized as a joint committee to consider whether their fundamental conceptions are the same or not, instead of wasting time in mutual recriminations of ignorance. In the scientific world, such charges can not, of course, go amiss, but conscious ignorance is better than unsupported assertion.

Whether the formation of crystals should be called fortuitous or not is another question of words; it will hardly be insisted that it is a completely fortuitous 'concourse of atoms' which makes crystals of regular form from a solution stirred up in a beaker; to cover our ignorance we ascribe to some substances a special property named crystallization. If protoplasm could be obtained from a similar dissolved mixture of its ingredients, this would be ascribed by parity of ignorance and logic to 'plasmatization' or whatever such a prop-

* SCIENCE, N. S., XVIII., 138, July 31, 1903.

† See, for example, 'A Text-book of Botany,' by Strasburger, Schenck, Noll and Schimper, p. 158, London, 1903.

erty might be called. But such a discovery would not end the physico-biological controversy, nor have any serious effect upon it, since we know already that the 'chemical compound' termed protoplasm, however originated, has numerous activities not shared by other compounds, and explainable only by the prediction of numerous thus far unexplained properties, such as assimilation, growth, irritability, reproduction, etc.

The biochemist hopes to make protoplasm in a beaker, but in transforming his homogeneous jelly into a 'sprig of moss' he will need to utilize agencies not only unexplained, but not even analogous to the postulates or properties now ascribed to unorganized matter. These agencies or properties of life are doubtless as 'natural' as those treated in physics and chemistry, but they are different. To call them 'creative' or 'directive' is, perhaps, open to objection, but they are certainly conservative, coordinative and constructive in a manner and degree for which we have no extravital analogy. The directive idea, however, is by no means extinct among biologists. Naegeli's '*Vervolkommungsprincip*' has been succeeded by an equally hypothetical 'mechanism of heredity' which Professor Weismann and his numerous followers are still seeking in germ-cells. It is possible, however, to frame an evolutionary theory without recourse either to 'phyletic vital force' or to incredibly complicated and yet inadequate mechanical determinants.*

It is needless to fear that Lord Kelvin will destroy the fact of organic evolution established by Darwin, but, on the other hand, no amount of argument can rehabilitate Darwin's first theory of the developmental process, that the environment causes variations and then selects the desirable changes. This view was abandoned by Darwin himself, and is now held in its original logical integrity by very few working biologists, the non-inheritance of acquired characters having rendered it untenable. The present multiplicity of theories of development is a sufficient indication that there is, as yet, no generally accepted explanation of evolution or of the other characteristic properties of life, and no 'complete mechanical theory of the universe.' Lord Kelvin will perform an important service for biologists if he encourages them to attempt an adequate formulation of the ascertained facts of their own science instead of thinking it necessary to base their structure on terms and concepts borrowed from widely separate fields of research.

The Vocabulary of Science.—The interest of such a discussion as that precipitated by Lord Kelvin is not confined to the varied opinions advanced; it furnishes also an excellent example of the more general and fundamental fact that the 'advancement of science' depends quite as much upon expression as upon investigation. This is true not merely because it is necessary to frame intelligible statements of scientific results which are to be of practical use, but because investigation itself can not advance far beyond the language in which its results must be interpreted. The rational arrangement or classification of facts is supposed to distinguish the methods and discoveries of science from those of mere accident and empiricism.

As soon as they leave concrete data and distinctions, scientific men fall to dogmatizing like any other theologians, metaphysicians or philosophers. This is not, however, because of any special inconsistency or weakness, but because all are at the mercy of an inadequate vocabulary and can say only what has been said already, or something sufficiently similar to require a new word only now and then. On the borders of knowledge each word does duty for a great variety of ideas, and the same proposition often conceals essential diversity of thought. The less known about a subject the easier to dogmatize, or to formulate and establish a vocabulary, and an established vocabulary is a fact to be reckoned with as much as any other.

Science and general literature are thus forever at war because, while comprehension advances from the concrete and particular to the general, the language in which ideas must be

*'A Kinetic Theory of Evolution,' SCIENCE, N. S., XIII., 969, June 21, 1901; 'Stages of Vital Motion,' *The Popular Science Monthly*, LXIII., 14, May, 1903.

formulated often develops in the contrary direction, from the abstract to the concrete. Generalizations built of facts are not abstractions, but collective facts, while the words in which they are expressed nearly always trace their origins back to primitive abstractions. 'Force' was originally a mere synonym of 'strength,' but has now become, in the minds of many, a physical entity, and 'heredity' or 'heirship' is actualized into a determining 'principle' of evolution. Philosophy came before science, metaphysics before physics and physics before biology, in the history of progress from the abstract to the concrete. The phenomena of personality are most familiar, but they have received the slightest scientific attention; in the phenomena of life we also participate, but have only begun to generalize, while the phenomena and theories of unorganized matter are formulated almost as extensively as those of metaphysics, and with the assistance of as many abstractions. Recent discussions of the constitution of matter read like metaphysical treatises, lacking only a certain ponderous assumption of certitude. The idealistic physicists argue that matter is electrical, while the materialists suspect that electricity may be material.

Forces and Properties.—In dealing with unorganized matter the physicist has an apparent advantage over the biologist, since he is able to command definite quantities and uniform materials and conditions of experiment, and thus secures results which can be stated in mathematical form, but this has not given him, as yet, an adequate insight into the nature and causal relations of the phenomena with which he deals. It is not the physicists who are attempting to extend their practice into biology, but the biologists who insist on paying tribute to physics, even after such an eminent specialist as Lord Kelvin has pronounced their case hopeless, unless recourse be had to other 'forces' than those at his professional command.

Physicists are willing to recommend 'vital principle' as an aid in biological difficulties because similar 'hypothetical entities' are much used to assist in the formulation of physical facts. That 'vital force' does not really explain anything is no objection to it from the physical standpoint; neither do other 'force' abstractions. Their function is merely to assist the mind to follow ascertained sequences of facts; they are our algebraic substitutes for unknown causal connections. As soon as we thoroughly understand the mechanism, the instinct of causality is satisfied and the hypothetical 'force' becomes superfluous; it is useful only if it assists observation and experiment. The old vital force which 'terribly hampered' biological investigation was a thoroughly bad abstraction, and has been consigned to a merited oblivion. The unwillingness of biologists to restore this idol or to set up another in its place should not, however, lead them to ascribe any superior virtue to the gods of the physicists, unequally doomed to dethronement.

Physicians have long since given over general theories of disease and are reconciled to treating symptoms and removing causes. When other branches of science have received a similar amount of study they may be content with phenomena and leave the 'entities' to the metaphysicians. Phenomena, instead of being assigned to unknown entities, are more conveniently and practically classified into groups called properties, and in biology we are ready to give up the notion that each property or group of phenomena must have a 'force' or other hypothetical entity behind it. The perception has come that the properties of life are not distinct 'forces,' but are merely different aspects of the same vital process. It is as a process rather than as a 'force' that life appears to lie beyond the phenomena of physics.

It did not improve matters to analyze evolution into two hypothetical opposing 'forces,' heredity and variation, or heredity and environment; these abstractions have long concealed the universal facts that organisms follow each other in series of similar but not identical individuals, and that species are not merely influenced by environment, but are normally in motion. There is no heredity which keeps organisms exactly alike, nor any

environment in which they will remain so.* The chief effect of these abstractions is to breed others as hypothetical as themselves. The facts are very simple, the abstractions become vastly complicated. Biologists are zealous for mechanical theories of their own making, but when Lord Kelvin fails to recognize these as adequate from the physical point of view and offers a 'vital principle' instead, the gift is rejected without thanks, and with the ungracious reply that it is a cast-off notion which ceased to be useful many years ago.

If evolution is ever explained in physical terms it will probably be done by making generous additions to the recognized properties of matter, a course to which physicists are certainly nothing loth, but they are duly warned by Professor Lankester that such 'facile and sterile hypotheses' will not satisfy biologists. Indeed, it may be that the failure to recognize a distinct category of vital phenomena lies not so much in what might be called a materialization of life as in a certain vitalization of matter. We predicate for matter our own mechanical limitations and refuse to consider such a possibility as the interaction or mutual sensitiveness of matter through space, although the alternative theories of ethereal media are extremely complicated and contradictory.

Comprehension versus Formulation.—Physics is considered fundamental to biology because organisms are made of matter, but biology is in advance of physics in the apprehension of its phenomena, and we are as likely to learn physics from biology as biology from physics. Life is, as it were, superposed on matter, and personality on life; each must have the qualities which make the next stage possible, but each stage may be viewed also on a plane of its own, and our intimate acquaintance with phenomena has not gone up from the bottom of the pyramid, but from the top down. The ultimate facts of matter appear fundamental from the mechanical standpoint, but the fabric of knowledge has been constructed thus far without them, and science must continue to advance laboriously from the known to the unknown. It may be illogical to discover the basal facts last, but such is the indication of history, to which it is well to be reconciled.

Every-day objects and incidents are the last to secure critical study and scientific elucidation; it is the obscure and incomprehensible which challenges our curiosity. Primitive man seems to have taken interest first in dreams and specters. Astronomy, as incidental to astrology, was the earliest of the physical sciences, and still owes much of its popularity to the instinctive attraction of mystery and awe. With mental habits and instincts formed by such a history it is not strange that thought still travels unwillingly from the remote and abstract to the concrete and adjacent, and that even in science we are continually tempted to value formulation above concrete perception, and to confuse abstraction with generalization. The cabala is discarded and the syllogism is distrusted; in time it will become apparent that even the mathematical equation yields only the amount of comprehension originally put into it, and has no virtue beyond any other method of accurate statement. The 'complete mechanical theory of the universe' is not yet, nor is its completion to be hastened by eking out the hewn stones of ascertained fact with blocks of the dried mud of abstraction. Such material may be very useful in temporary shelters for the workmen, but it has no place in the permanent structure.

A General Classification of Phenomena.—Although abstractions and 'hypothetical entities' must be excluded from among the results of scientific study, there is still great need of general terms as a means of arranging ideas and classifying facts. It is here that biology may possibly aid her sister sciences, since biological classification is more concrete than any other, being based on ascertained causal sequence or common descent. Other classifications are of value in proportion as

* "* * * the *law of heredity*, would, if nothing interfered, keep the descendants perfectly true to the physical characters of their ancestors; they would breed true and be exactly alike."—*Coues.*

"Were it possible for growth to take place under absolutely constant external influences, variation would not occur. * * *"—*Weismann.*

they serve a similar purpose. When the causal relations are prominent the analogy with biology may be close; in other instances the resemblance is only formal; the categories or grand divisions become mere abstractions, and the resulting association of facts follows no natural sequence. Philosophers who have sought to frame ultimate classifications have largely neglected to take advantage of the concrete basis of arrangement afforded by the coherence of the biological series.

To integrate everything to the unity of a single 'substance' or 'principle' (monism) is an idealization of mathematical concepts for which no objective reasons have been adduced. Matter, life and person* appear, as yet, to be final categories of phenomena, comprising different series of properties and meriting separate vocabularies. The second and third categories are not, it is true, independent of the first or of each other, but no causal nexus has been established. Matter gives us elsewhere no hint of the power of vital coordination, and consciousness is no necessary part or consequence of biological evolution. The materialist defines matter so as to include the other categories, while the idealist would annex the universe to the realm of thought. From the middle ground of biology it is apparent that such assumptions are devoid of practical meaning, in that they correspond to no perception based on objective experience. It is easy to say 'protoplasm is a chemical compound' or 'matter thinks,' but these integrations are born of the confusion of words rather than of the conception of ascertained facts. The chemist will find that protoplasm is not a single compound, but an ever-varying infinity of compounds, each capable of work of which 'unorganized' matter has given no suggestion. Neither is it necessary to confuse deliberate purpose with chemical affinity or physical reaction, in the vain attempt at the construction of a specious universal equation.

Students of nature have labored mightily, and they must also wait patiently. Science is advanced neither by disconnected particulars nor by meaningless generalities; all possible associations of facts are to be considered, but essential distinctions must not be neglected and the unlike confused. To recognize biological phenomena as distinct from those of physics does not require belief in an intermittent creation or a polytheistic theology, as suggested by Professor Lankester; the diversity is not lessened by ascribing it to gradual changes which both the physical conditions and the organisms have experienced 'since life began,' whatever that may mean. And until we know vastly more than we do about life and matter, nothing is to be gained by confusing either the phenomena or the vocabularies of biology and physics. Science observes, classifies and interprets facts, with the assistance of language, but neither facts nor words are science by themselves.

O. F. COOK.

WASHINGTON, D. C.
October 16, 1903.

* As a designation for the third category of phenomena this term, though open to many objections, seems preferable to consciousness, as being at once more general and more particular. Consciousness is a property of person as inertia is a property of matter and evolution a property of life; in this sense consciousness does not become synonymous with intelligence, memory, instinct or mere protoplasmic irritability, as sometimes implied by Minot and other biological writers. Instincts, and even mental arts, such as language, are attainable without subjective intelligence or deliberate thought.

AGRICULTURAL EXHIBITS AT ST. LOUIS.

A PAMPHLET has been issued containing a description of the collective exhibit of the colleges of agriculture and mechanic arts and the agricultural experiment stations of the United States in the Palace of Education at the Louisiana Purchase Exposition. The exhibit, as the pamphlet explains, is intended to illustrate the progress of education and research in agriculture and the mechanic arts in the United States, showing those distinctive features of the work of the land-grant colleges and experiment stations which differentiate them from other educational and scientific institutions. It is probably the most complete and comprehensive display of its kind that has ever been attempted and is believed

to furnish an instructive exposition of a phase of educational and scientific effort which is rapidly extending and is already exerting a potential influence in developing the industries and resources of the country. It is safe to say that in no special field of education and research has there been greater progress during the past decade than along the agricultural, industrial and technological lines represented by the land-grant colleges and experiment stations. The exhibit is under the control of the Government Board, and has been prepared under the general management of a committee of the Association of American Agricultural Colleges and Experiment Stations, of which Dr. W. H. Jordan, director of the New York Experiment Station, is chairman. Mr. James L. Farmer, special agent of the Government Board, is in immediate charge. The exhibit occupies about 16,000 square feet of space very favorably located in the Palace of Education. In addition to the displays of the U. S. Bureau of Education and of the Office of Experiment Stations of the U. S. Department of Agriculture, which represent the national government in its relations with these colleges and stations, the space devoted to agricultural exhibits is divided into fifteen sections, that occupied by the mechanic arts exhibits into nine sections. The displays in these sections have been prepared with the collaboration of experts selected from the faculties of the land-grant institutions, agricultural experiment stations and the U. S. Department of Agriculture, and cover all of the principal subdivisions of agriculture and mechanic arts.

The agricultural exhibits include soils, fertilizers, plant laboratory, field crops, horticulture and forestry, plant pathology, economic entomology, classed under the general head of agronomy or plant production; animal husbandry (investigation), animal husbandry (instruction), and veterinary medicine, classed under the head of zootechny or animal industry; dairy laboratory and sugar laboratory, classed under the head of agrotechny or agricultural technology; rural engineering, or farm mechanics; rural economics or farm management; and inspection. The mechanic arts exhibits include civil engineering, mechanical engineering, electrical engineering, mining engineering, technical chemistry, architecture, drawing and shop practise (including textiles and trades), domestic science and ceramics.

HONORARY DEGREES CONFERRED BY THE UNIVERSITY OF WISCONSIN.

On the occasion of the recent jubilee celebration of the University of Wisconsin, the doctorate of laws was conferred on some forty delegates. The words addressed by President Van Hise to several of the candidates were as follows:

Henry Prentice Armsby—Formerly professor at this university, with the aid of ingeniously devised apparatus you have for years been successfully working upon the very important problems of metabolism of food nutrients. Upon you, for these valuable researches on the nourishment of the body, and for vigorous administration of the Pennsylvania state agricultural experiment station, we confer the degree of doctor of laws.

Thomas Chrowder Chamberlin—It is with the greatest pleasure that I confer upon you the degree of doctor of laws. The University of Wisconsin owes you much. As her president for five years, you contributed to her development and upbuilding more than can be estimated. She honors you to-day for this, and also for your contributions to the science of geology. In your work in connection with the state and federal surveys, and in your comprehensive scientific investigations regarding the principles of ore deposition, the Pleistocene formations and the evolution of the solar system, you have combined in a rare manner patient collections of facts, discriminating reasoning power and constructive scientific imagination. You have richly deserved the highest academic honor in the gift of this university.

John Dewey—Profound philosopher and psychologist, you have successfully applied your learning to the study of childhood and youth. You have been an inspiration and a guide to students of education in every progressive country. For distinguished service

in the development of educational theory and practise this university confers upon you its degree of doctor of laws.

WILLIAM GILSON FARLOW—For your fundamental contributions to the morphology and classification of cryptogamic plants, in which you have advanced our knowledge of the evolution of plant life; for your valuable studies in applied botany, and because of your distinction as a representative of all botanical enterprises of international scope, the University of Wisconsin confers on you the degree of doctor of laws.

GROVE KARL GILBERT—Deep interpreter of nature, scientist of balanced judgment, geologist of the first rank, preeminent in the development of physiography; upon you, especially for the masterly formulation of the principles of erosion, by the authority of the regents I confer the degree of doctor of laws.

FRANKLIN PAINE MALL—Foremost investigator in anatomy in America, leader in recent advance in medical education, you have established productive departments of anatomy in three universities. Your teaching has inspired a strong group of disciples doing important work at this and other universities. You are well worthy the honor of all, for your aim is to decrease human suffering. This university, therefore, confers upon you the degree of doctor of laws.

EDWARD LAURENS MARK—This university confers upon you the degree of doctor of laws in recognition of your profound researches upon embryology and the animal cell, and of your services, for more than a quarter of a century, as the head of a great laboratory in which many of the zoologists of this country have been trained in the methods of fruitful research and inspired with the highest ideals of their science.

ELIAKIM HASTINGS MOORE—Teacher stimulating the study of the higher mathematics in America; leader accomplishing much for the betterment of mathematical instruction in schools of all grades; mathematician, whose erudite labors and fruitful research in an ancient science have made the world your debtor, upon you, for mathematical investigations, by authority of the regents, I confer the degree of doctor of laws.

ALFRED NOBLE—I confer upon you the degree of doctor of laws on account of your eminence as an engineer, a scientist and a man of affairs. Your skill in large construction, your broad views and sound judgment, and your knowledge of applied science, have made you an eminent expert and enabled you to make important contributions to the solution of the great problems of transportation.

SAMUEL LEWIS PENFIELD—Your determination of the molecular structure of complex minerals and researches upon the relation of crystal forms to chemical composition have advanced the knowledge of the constitution of matter. For determinative mineralogy you have written the authoritative text. Worthy successor of your illustrious predecessors Silliman and Dana, you have won fresh laurels in science for Yale University. In recognition of this work we confer upon you the degree of doctor of laws.

AUGUSTE RATEAU—In recognition of your achievements as a mechanical engineer, as a contributor to the science of the flow of fluids; as a distinguished inventor of steam turbine engines and as an author of standard books in engineering, upon the recommendation of the faculty, by the authority of the regents, I confer on you the degree of doctor of laws of the University of Wisconsin.

EDGAR FAHS SMITH—For pioneer work in the electrolytic separation of metals; for valuable researches upon the compounds of tungsten, molybdenum and uranium; for the training of a large number of scholars devoted to the advancement of the science of chemistry, this university confers upon you the degree of doctor of laws.

EDWARD BRADFORD TITCHENER—Through your skill in experimentation and your independence and sanity of judgment, you have become a leader in modern psychology. In many ways, and especially by your laboratory manual of experimental psychology, you have contributed to the creation of a new department of university study. For this work, the university confers upon you the degree of doctor of laws.

James Wilson—From the presidency of Iowa Agricultural College you were called to the cabinet by William McKinley. By President Roosevelt you were retained as the head of the United States Department of Agriculture. Under your solicitous care scientific work has risen to first place in the greatest bureau of agricultural research in the world. Upon you, for the encouragement and fostering of agricultural education and research, and thus helping to dignify the great fundamental vocation of agriculture, this university confers the degree of doctor of laws.

Robert Simpson Woodward—As a mathematician you have departed from the beaten paths and have applied your art with unusual power to new fields in the border-land between astronomy, geodesy and geology. In recognition of your important contributions to knowledge in this department of learning, the university confers upon you its honorary degree of doctor of laws and welcomes you to its fellowship.

SCIENTIFIC NOTES AND NEWS.

Dr. W. H. Maxwell, superintendent of schools in New York City, has been elected president of the National Educational Association.

The honor of knighthood has been conferred on Professor James Dewar by King Edward.

Professor Robert Koch has been elected a member of the Berlin Academy of Sciences, filling the vacancy caused by the death of Professor Virchow.

Oxford University proposes to confer the degree of D.Sc., *honoris causa,* upon the following persons, on the occasion of the visit of the British Medical Association: Thomas Clifford Allbutt, M.D., F.R.S., regius professor of physics at Cambridge; Andrew Clark, F.R.C.S., vice-president and chairman of the council of the British Medical Association; Thomas Dryslwyn Griffiths, M.D., president of the British Medical Association; Jonathan Hutchinson, F.R.S., late president of the Royal College of Surgeons; Sir William Macewen, M.D., F.R.S., regius professor of surgery in the University of Glasgow; Sir Patrick Manson, K.C.M.G., M.D., F.R.S.; Sir John William Moore, M.D., late president of the Royal College of Physicians of Ireland; William Osler, M.D., F.R.S., professor of medicine at Johns Hopkins University, Baltimore; Thomas George Roddick, M.D., M.P. (Canada), late president of the British Medical Association.

Dublin University has conferred its honorary doctorate of science on Mr. Philip Watts, Sir James Dewar, Mr. Jethro J. Harris Teall and Dr. William Henry Thompson.

Mr. William H. Nichols, president of the General Chemical Company and of the Nichols Chemical Company, has received the doctorate of laws from Lafayette College. Dr. Nichols has also been nominated by the council of the Society of Chemical Industry, to succeed Professor Ramsay as president.

Sir William Ramsay, Sir Henry Roscoe and Professor Landolt have been elected honorary members of the German Bunsen Society.

Sir Francis Sharp Powell has been elected president of the Royal Statistical Society.

The General Assembly of the State of Maryland voted, at its recent session, a gold medal to Colonel Charles Chaillé-Long, in recognition of his contribution to the solution of the Nile problem by the discovery of Lake Ibrahim in 1874 and his services to humanity rendered at the time of the bombardment of Alexandria in 1882.

The Franklin Institute, Philadelphia, will confer the Elliott-Cresson medal on Dr. Hans Goldschmidt in Essen-Ruhr, Germany, in recognition of his distinguished work in aluminothermics.

We learn from *Nature* that the French Society of Civil Engineers has this year awarded its prizes as follows: the annual prize to M. J. Bernard for his work on the installation in the Red Sea of three lighthouses in circumstances of especial difficulty. The Michel Alcan prize was awarded to M. L. Guillet for his researches on the composition of steel, and the F. Coignet prize went to M. V. Picou for his work on the regulation of dynamos. A prize was awarded to Professor

E. Hospitalier for his works on the study of phenomena which by their rapidity and frequency baffle ordinary methods of analysis.

MR. H. C. RUSSELL, government astronomer of New South Wales, will retire at the end of the present year, after a service of forty-six years.

DR. A. P. LUFF has resigned his appointment as scientific analyst to the Home Office of the British government. Dr. W. H. Wilcox has been recommended by the Council of the Royal College of Surgeons of England, as his successor.

DR. JOHN BELL HATCHER, curator of vertebrate zoology at the Carnegie Museum, Pittsburg, died on July 4 from typhoid fever, at the age of forty-six years.

WE regret to record the death of M. Anatole de Barthélemy, the eminent French archeologist, at the age of eighty-three years; of Dr. W. Weiss, professor of mathematics at the German Technological Institute of Prague, on June 18, at the age of forty-five years; of Dr. V. Merz, formerly professor of chemistry at Zurich; of Dr. Gilles de la Tourette, the well-known French alienist; of Mr. Edward Trimmer, for thirty-six years secretary of the Royal College of Surgeons, England; and of Lieutenant-General Dubrovin, who was for a long time secretary of the Imperial Academy of Sciences at St. Petersburg.

THE *Geographical Magazine* states that the Russian Geographical Society, with the aid of money subscribed by a private person, is organizing a new expedition for the exploration of the northern coasts of Siberia, between the Yenisei and the Lena. The head of the expedition will be M. Tolmacheff, already known for his journeys and explorations in Russian Asia.

IN January, 1905, the Bombay branch of the Royal Asiatic Society proposes to celebrate the centenary of its foundation by a public gathering, at which papers will be read and an exhibition of the possessions of the society held.

THE International Astronomical Congress will meet at Lund, Sweden, beginning on September 5.

THE subject of the essays for the Howard medal of the Royal Statistical Society for 1905 will be 'A Critical Inquiry into the Comparative Prevalence of Lunacy and other Mental Defects in the United Kingdom during the last 50 years.'

A *conversazione* of the Institution of Electrical Engineers was held on June 28 in the Natural History Museum, London. The guests, who numbered about 1,500, were received by Mr. R. K. Gray, president, and Mr. Alexander Siemens, president-elect.

A CABLEGRAM to the daily papers from London, dated July 8, says that the annual report of the Cancer Research Fund was submitted at the third annual meeting. It stated that the investigations of the year had resulted in discoveries having an important bearing on several crucial problems in connection with the disease, knowledge of which had been greatly increased. Briefly and untechnically stated the new facts are that cancer pervades the whole civilized and uncivilized world. Hence it is not, as was supposed, a produet of civilization. It affects animals as well as human beings, and also fishes. It attacks all subjects at relatively the same age. It is not infectious and is not transmissible from one species to another. The cancer cell can reacquire powers of self-propagation. Cancer is not attributable to a parasite. It is not increasing. Experiments have not shown that radium exercises a curative effect.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the death of Mrs. Susan W. Clark, Clark University will receive $400,000, left in trust for her use, and a further sum of $50,000 to $75,000 from her estate.

MR. JOHN D. ROCKEFELLER has given Denison Baptist University, Newark, Ohio, $100,000.

IT is reported that the Sheffield Scientific School, Yale University, will have a large en-

tering class. There were 326 freshmen last year, against 207 the previous year. The returns from the entrance examinations show that there were 730 candidates for admission to the school against 651 a year ago, an increase of 79. Of these there were 372 last June, a gain of 36. There was a similar increase in the candidates who took the preliminary papers. The number this year was 358 against 315 last year, a gain of 43.

Dr. Charles Schuchert, of the U. S. National Museum, has been appointed professor of historical geology in the Sheffield Scientific School of Yale University and curator of the geological collections in succession to the late Professor Beecher.

Dr. Dickinson S. Miller, instructor in philosophy in Harvard University, has been elected lecturer in philosophy at Columbia University.

Recent changes in the scientific faculty of the State University of Iowa are as follows: The department of physics has been divided, Professor A. A. Veblen retaining the chair of experimental physics, while Professor A. G. Smith has been transferred from the chair of mechanics in the department of mathematics to a new chair of physics and mechanics. Dr. R. T. Wells will continue to act as professor in charge of electrical and mechanical engineering. The chair of civil engineering, made vacant by the resignation of Professor A. V. Sims, will be filled before the opening of the coming academic year. Following the resignation of Dr. L. W. Andrews from the chair of chemistry in the college of liberal arts the reorganization of the work of instruction in this branch for the entire university has been assigned to Dr. E. W. Rockwood, heretofore professor of chemistry and toxicology in the colleges of medicine. An instructorship in metallurgy has been established which is yet to be filled. Additional instructors in mathematics and in mechanical drawing are also to be appointed.

The following additions have been made to the faculty in the scientific departments of the University of Kansas: H. D. Hess, of Lehigh University, 1896, has been elected associate professor of mechanical engineering and director of the Fowler shops; Albert K. Hubbard, Yale, 1901, assistant professor of civil engineering; George F. Kay, Ph.D. (Chicago, 1904), Toronto University, 1902, assistant professor of geology and mineralogy; Robert W. Curtis, Ph.D. (Yale, 1904), Trinity, 1896, assistant professor of chemistry; Wm. J. Baumgartner, Ph.D. (Chicago, 1904), University of Kansas, 1900, instructor in zoology; Charles G. Rogers, Ph.D. (California), instructor in physiology.

The following appointments were made in the medical faculty of the Johns Hopkins University: Dr. Percy M. Dawson, associate professor of physiology; Dr. Joseph Erlanger, associate professor of physiology; Dr. Warren H. Lewis, associate professor of anatomy; Dr. Arthur S. Lowenhart, associate in physiological chemistry and pharmacology; Ernest G. Martin, Ph.D., instructor in physiology; Dr. Augustus G. Pohlman, instructor in anatomy; and Dr. George L. Streeter, instructor in anatomy.

A fellowship is vacant in the Department of Chemistry, Ohio State University, Columbus, Ohio. The value of the fellowship is $300 and in addition the student is exempt from all fees. Applicants should apply to Professor William McPherson.

The Yale corporation has accepted the resignation of Professor George Trumbull Ladd, head of the department of mental philosophy and metaphysics.

Professor Des Coudres has been appointed director of the newly established laboratory for theoretical physics at Leipzig.

A new chemical laboratory has been dedicated at Karlsruhe which will be under the direction of Professor Engler.

Professor Krehl, of Tübingen, has been invited to the chair of medicine at Strassburg, left vacant by Professor Naunyn's retirement.

Dr. Jos. Wellstein, professor of mathematics at Giessen, has been called to Strassburg.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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*DOES A TECHNICAL COURSE EDUCATE?**

BEFORE we can answer the question 'Does a Technical Course Educate?' it is necessary that we understand what education should mean. We do not need to trace this word back to its root, to find its derivation in some ancient language and to learn its exact meaning in that tongue, but rather to find what it has stood for in the thoughts of men, what processes have been necessary to produce it and what its value has been to those possessing it. If we take a brief look at some of the methods and ideals of education in the past we may receive light upon its proper meaning to-day. Education is for the benefit of the individual or for the benefit of the state. In Persia, in Egypt, in Greece, in Rome, the individual was nothing, the state was everything. The hopes, the desires, the wishes of men were not considered; the growth and prosperity of the state were paramount. In Persia and Sparta education was for war. The education of the body was for the many; the education of the mind for the few. Aristotle was the first to teach that the ultimate end of education is the ability to enjoy the blessings of peace.

Society derives its ideals of education at any epoch from the limits of knowledge at that epoch. A man can teach only what he knows. If he knows but little he can teach but little; if the sum of human knowledge is small, there is but little to be taught, although there is much to learn. In the early days of Greece the Trivium and the Quadrivium embraced all knowl-

* Inaugural address of the president of Case School of Applied Science, May 11, 1904.

edge. Grammar, rhetoric and dialectics were taught to all who entered the schools; arithmetic, geometry, astronomy and music were reserved for the more advanced, who were few in number. The former were language studies; it was understood then as now that language, one's own language, is the most important subject for the beginner to study. It is a significant fact that the Greeks studied no language but their own. In Rome, too, all knowledge was found in the Trivium. Having little else to study, the Greeks and Romans each built up a language and a literature which have never been surpassed, the former for its scientific accuracy, the latter for the beauty of its thought and the elegance of its diction. The sciences of the Quadrivium were slowly developed by the Greeks, the Romans and the Arabs, and in the case of geometry and music were brought to a high degree of perfection. But science in these early as in later days met with much opposition from those whose chief study was language or philosophy. Socrates believed that the study of science was profitless and wrong, 'for he did not think that such matters were discoverable by men, nor did he believe that those acted dutifully towards the gods who searched into things that they did not wish to make known.' Locke must have been reading Socrates when two thousand years later in his 'Thoughts on Education' he said: "Natural philosophy as a speculative science, I imagine we have none, and perhaps I may think I have reason to say we never shall be able to make a science of it. The works of nature are contrived by a Wisdom and operate by ways too far surpassing our faculties to discover or capacities to conceive, for us ever to be able to reduce them to a science." During the dark ages ignorance and superstition blotted out all education and all desire for education among European peoples, the Moors of Spain alone excepted. Some remnant of learning remained in the monasteries, but it was only enough to accentuate the intellectual darkness which enveloped the nations.

The rise of the mediæval universities marked the revival of learning. In Paris, Oxford, Bologna, Prague, Vienna and many other cities were established great schools of the liberal arts, law, medicine and theology. The Trivium and the Quadrivium were still the principal subjects studied. Learning was surrounded by a high wall and the only entrance to the sacred enclosure was through the Latin gate. All books were in Latin; Latin grammar and rhetoric were first studied. Pupils slowly repeated grammatical rules recited by the teacher and then learned by rote the works of the classic authors. Dialectics next received attention and pupils spent years in wrangling in Latin over disputed constructions in grammar or knotty points of law and theology. There was no vernacular literature. The lore of the ages had been concentrated in Greece and Rome, and though these countries were now shorn of their ancient splendor, they still dominated the world of learning. This was but natural, as the languages of western Europe were crude and unformed, while the classic tongues were polished and refined. Latin was the language of the educated; a knowledge of it opened the door to all art, literature and science. It was the badge of an aristocracy, a secret brotherhood of learning. Those within the order had certain privileges not possessed by others and they looked down upon those outside their ranks. The education of this period lifted men out of the ignorance in which they had been engulfed for centuries and gave them all the knowledge of the world. This knowledge was centuries old, it is true, but it was fresh and new for those who had rediscovered it. They churned it over and over, pressed it into

new forms and expressed their wonder and admiration at the beauty they found in it. But as a rule they made no effort to improve upon it, to discover new truths or to impress their own thoughts upon the world. The student who receives all his knowledge in a foreign tongue, different from the language of his every-day life and thought will seldom add to that knowledge. Truth reveals itself to him who diligently seeks it at all times and places, whose every thought is given to the search and whose mind is open to receive it even when engaged in the most commonplace affairs of life. A man living in his native country thinks in his own tongue; if there are no words in that tongue to express the ideas which come to him, they are apt to pass unheeded.

The dawn of the renaissance brought new factors into the intellectual life of Europe. The several languages settled into fixed forms and became more refined. Reading, writing and arithmetic were taught in the mother tongue and so education spread among the common people. Scholasticism gave place to classic culture and the study of history, philosophy and mathematics became more common in the universities. Latin was still the language of learning and the classic authors the chief source of culture. During the centuries which have followed, the changes in methods and subjects have been slow. In the past the teacher has been the most conservative of men. He has taught that which he himself learned and has followed the methods of his teachers. Education has been a rigid mold, a cast-iron form into which all were pressed and came out exactly alike. All culture and the greater part of learning were embalmed in the classic tongues and these mummified forms were thought to be eternal and unique. But the spirit of scientific enquiry has shattered the mold and one subject after another has been added to the curriculum of the university. Men have come to see that language is a means and not an end; that the true subject for study is not grammar, but the universe. It has taken many centuries to show that education is many-sided and of many forms. Until within a few years the curriculum at each college has been fixed—so much language, so much mathematics, so much philosophy, so much or rather so little science. The student who had no taste for mathematics was forced to do as much as the one whose taste was for formulas and numbers; he who disliked language must cram Latin and Greek for years or he could not be called an educated man. But new ideas and new methods have come within the last half century. It has come to be recognized, the advocates of the new method say, that all men are not alike, that what is suitable to develop the mind of one will not answer for another. Individual tastes and capacities have been at last respected and no student is now forced to try to become a linguist or a mathematician or a philosopher or a scientist or a weak combination of them all against his wishes. The educational pendulum has swung from the conservative to the radical side and now the student may decide to specialize in chemistry, or logic or Anglo-Saxon before he knows what these terms mean. In some respects we have reverted to the methods of the mediæval universities, for now as then a student may graduate without much knowledge of his mother tongue.

Which of the methods so hastily mentioned has produced true education and which results shall we use to settle the question under discussion? Is the true method that of the Chinese which taught a worship of ancestors and a reverence for antiquity; or that of Persia and Sparta which prepared men for war; or that of Athens, which in the words of Milton

'taught men to perform justly, skilfully and magnanimously all the offices, both public and private, of peace and war'; or that of ancient Greece and Rome which developed an almost perfect language and literature and produced an art and philosophy which have been the admiration of the ages; or that of the mediæval universities which revived a part of the old learning but added nothing new, or that of the centuries succeeding the renaissance which laid chief stress upon classic culture but developed a vernacular literature and gave birth to the sciences; or that of the present with its tendency to absolute freedom in the choice of studies? Among this diversity of methods and results it is difficult to select a criterion by which to settle our question. Many definitions of an educated man have been given, but among them all I know of none that will appeal to a scientific mind like that of Huxley. He says: "That man, I think, has a liberal education, whose body has been so trained in youth that it is the ready servant of his will, and does with ease and pleasure all that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength and in smooth running order, ready, like a steam engine, to be turned to any kind of work and to spin the gossamers as well as forge the anchors of the mind; whose mind is stored with the knowledge of the great fundamental truths of nature and the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions have been trained to come to heel by a vigorous will, the servant of a tender conscience; one who has learned to love all beauty, whether of nature or of art, to hate all vileness, and to esteem others as himself."

Without attempting to rival this and other definitions, I may say that considering the subject from an intellectual standpoint only, if we are to train educated men I believe we must teach our students to know, to search, to think. To know—what? This is the question which our institutions of learning have been trying for many centuries to solve. When all knowledge was embraced in the Trivium, the problem was easy. He who mastered the Trivium was educated. Now the very extent of knowledge makes the problem difficult. The chemist, the mathematician, the botanist, the philologist, each declares that unless a man knows something of his specialty he is not broadly educated. Enough is known in mathematics to keep a student busy for his entire life, and the same is true of all other branches of learning. The poor student is urged on by one teacher and conditioned by another, is given lessons by each long enough to consume all of his study hours, and wonders why he is obliged to try to master things he does not like; or turned loose to browse as he pleases, seeks too often the easiest paths and gains but one side of an education. No man can know all there is to know. However great his attainments, however broad his sympathies, however brilliant his intellect, he can only prospect a little on the mountain of knowledge. Is it necessary to know all? Are there not some things a knowledge of which is necessary in education, and others which can be left to the individual taste? I believe that in the future all colleges will answer this question, as some have already done, in the affirmative. Those which still adhere to the required curriculum must permit a certain amount of natural selection, while those which offer almost absolute freedom in choice of studies must place more restrictions upon youthful tastes. And what are these necessary subjects which all should master? First and foremost is one's own language. The ability to speak and write the mother tongue should be insisted upon

in every scheme of education. It is evident that the secondary schools can not complete this work. The entrance examination papers in every college show that the students know very little about rhetoric and composition. It is a slow process to teach a student to express himself clearly, concisely, elegantly. Cato said, 'Get a firm grip on the matter and words will follow fast enough.' This may have been true two thousand years ago, but either it is not true to-day or our students do not conform to the condition. The English language should be studied from the time the student enters college until he leaves if he is to be master of his own tongue. Modern languages, two at least, should also be insisted upon. Knowledge is not circumscribed by boundary lines nor learning located by latitude and longitude. No one country, no one language contains all the educated man should know. The study of literature will naturally be coincident with the study of language. The great thoughts of some of the great men of all ages should be known and understood. The range of reading should be wide, the critical study of style and content be confined to a few authors. History should be included in the list of necessary subjects. The history of one's own country should be well known; the history of other countries restricted to the most important events. Most of our college students have not studied American history since they were in the grammar schools and few if any of our colleges make it a required part of the curriculum. Can any knowledge be more important to the educated man than the history of his own country, and is the amount acquired in the grammar school before he is fourteen years old sufficient? History should not be confined to great events or to the manners and customs of the people, but should include past and present politics. Many years ago there was inscribed upon the walls of the historical rooms of Johns Hopkins University the words of Freeman, 'History is past politics; politics is present history.' Past and present political parties, the principles they have or do stand for, the success or failure of their policies and their effect upon the welfare of nations, may well be required. The study of civil government is closely allied to the preceding. Very few of our college students can describe the government of the cities in which they live or tell the names and functions of the several courts of justice in their native states. Economics, though not a required study in most of our colleges, is one with which all should be familiar. The functions of land, labor and capital, the relations of labor and capital, the nature of supply and demand, money, production, distribution, wages, rent, taxation, tariff, should all be understood. Philosophy and ethics should, I think, receive a small amount of the time devoted to required studies. Nor can a man be called educated unless he knows something about art. The several schools of painting and sculpture, the great paintings, the great statutes, the masterpieces of architecture, should all be familiar to the student. Chemistry and physics have made the wealth of our modern world, have revolutionized our mode of living, have dictated the policy of nations and have changed the course of history. Yet how few of our institutions of higher learning require either of them except as entrance subjects? There is very little in mathematics which is necessary for the educated man to know. Arithmetic, algebra and geometry are studied in the secondary schools and from the standpoint of knowledge nothing else need be required.

Botany and astronomy are likewise necessary. The educated man moves among the trees, the plants, the flowers, by day, and

sees above him the planets and constellations by night. No more than in the days of Job may he bind the sweet influences of the Pleiades or loose the bands of Orion, but he should know the north star when he sees it and be able to tell why the Copernican theory is true.

Am I requiring the educated, the broadly educated man to know too much? He can learn something of all these subjects during his college course and yet have a great deal of time left to follow his own individual tastes. The standard by which to judge the technical course, to ascertain its deficiencies, must be broad. In these days of telephones, electric cars, X-rays and the wireless telegraph ought we to call a man educated if he has not given considerable time to the study of physics? Ought we to call a man educated if he does not know the history of the great political parties and our methods of government? Ought we to call a man educated if he moves among the phenomena of nature by day and by night with no more knowledge of them than if he were blind? And yet we are graduating from our colleges many men who know little or nothing of any of these subjects and we do call these men educated. The educated man is to live in his own generation; he is a citizen of to-day, not of yesterday or to-morrow, and he should know those things which will fit him for the business, social and political life of his own time.

To search. However much a man may know, there is yet more to be known. It is not necessary for the educated man to know everything, but it is necessary for him to be able to find anything in the realm of knowledge. He should be taught how to use indexes, dictionaries, encyclopedias and other books of reference; libraries, art galleries and museums should open their stores to him when he bids them. Every one knows how to look up a word in a dictionary or an article in an encyclopedia, but the systematic use of all sources of information is rarely taught. The student has not been fully initiated into the mysteries of his order until he has been taught to search. Then the freedom of the scholar is his and the universe lays its treasures at his feet.

To think. The most important and the most difficult! Man may be by nature a thinking animal, but if so, he does his utmost to conceal his powers. The faculty of original thought never comes to most men. In childhood we must accept what is told us, and we become so accustomed to receiving our ideas from others that many of us never outgrow it. We believe without question what we read in books, magazines and newspapers, what we hear in the classroom and from the pulpit and platform. But the broadly educated man must think for himself. The mind, like the body, should be put through certain exercises to gain strength. Mathematics and the ancient languages, which have been omitted from the list of things the educated man should know, are among the most powerful influences for training the mind. This is why they have held such an important place in the curricula of our colleges. But they are not the only subjects which will stimulate mental thought and teach the mind self-reliance. A man may grow strong by rowing, by using chest weights or by chopping wood. Any one of these will stimulate the nervous system, send the blood to all parts of the body and keep every muscle in a healthy condition. The proper study of chemistry or philosophy or thermo-dynamics will have a like effect upon the mind. But there are many muscles in the body; if a man uses his biceps only, he will not grow strong in the legs. And there are many powers of the mind. If the intellect is to have all its powers of equal strength, as Huxley advises, the man must be taught to think in

more than one direction. He must study language, mathematics, science, philosophy, not for knowledge only, but for discipline.

If these requirements, which, I confess, have a large personal equation, are necessary to produce education, does a technical course educate? Perhaps it would be proper first to inquire: do our colleges and universities educate? Do they teach their students to know, to search, to think? Have they not gone too far in the direction of allowing any man to study anything? But it is the technical school and not the college which is under discussion. The technical school is a professional school and its duty is to train its students for active professional life. It is not a university nor a college. Its aims and its methods are different from either. Its business is to teach, and if it does not teach, it has no excuse for existence. In a university, the faculty are expected to do little teaching and much research work; in a technical school they are expected to do much teaching and little research work. Research and expert work are advisable to a limited extent—limited, however, only by the time and strength the instructor has left after his regular work is done. They should be encouraged by the authorities in every possible way under the above restrictions. Research work is the legitimate outcome of learning to think. He who possesses the power will find ways and means to use it. Coal burned in our furnaces yields but a fraction of its energy in useful work; the sun's rays shining upon the roofs of our manufactories have stored up energy enough to light and heat the buildings and to operate all the machinery within, but we use none of it. Surely there is opportunity for original work by the engineer. The community has a right to demand that the professor in a technical school shall do expert work. The knowledge he possesses, the laboratories and apparatus at his command should be for the use of the community whenever this will not interfere with his first duty as a teacher.

Engineering is a learned profession. Schools of law, medicine and theology do not attempt to give a broad education. They either require a liberal training for admission or they admit students from the secondary schools. In both cases the course of study is the same. The engineering student usually comes directly from the secondary school. It would be possible to give him drawing and shop-work at once, to furnish him with tables and empirical formulas and have him begin technical work immediately. But this would make him a mere machine and not an educated engineer. The technical schools recognize that they are training for a learned profession and require the students to give the greater part of their time for two years to liberal studies. The purpose of the Roman schools was utilitarian, but they furnished a sound training. The purpose of the technical schools is likewise utilitarian, but they give a broad and liberal education as far as they go. English is thoroughly taught during the time devoted to it. The training in modern languages is good, although its chief aim is to teach the students to read scientific books and periodicals. Mathematics is thoroughtly taught; it has to be for it is the basis of all engineering work. Physics and chemistry are required to a greater extent than in any college. Economics is required in some and offered as an elective in many others. The technical student is taught to search. Books of reference, periodical literature, proceedings of societies and government reports are made a part of his education. And an effort is made to teach him to think. The connection between theory and practice can only be learned by vigorous mental effort. It is only by right thinking along scientific and mathematical lines that the

student learns to transform a theorem into a dynamo or a formula into a compound engine.

And thus I am led to the conclusion that a technical course does educate to a limited extent. It teaches the student to search and it teaches him to think; it teaches him some of the things that an educated man should know, but it does not teach him all that an educated man should know. It would be much better if our technical graduates were broadly educated men as well as trained engineers, if they had received a college training before entering upon a technical course. In a university it would be easy to require this. Two courses would be open to the student. He could complete his college work with no reference to technical subjects and then enter the engineering department; or after completing those subjects which are considered necessary for a liberal training, he could choose a part or the whole of his electives in the technical school. In the former case his combined college and professional course would require six or seven years; in the latter case five or six years. Some of our universities have such a requirement and I am glad they do. I believe the student should be trained to know, to search, to think before he enters the technical school. During his whole life he would have a broader outlook, a deeper sympathy with men and events, a greater influence upon the community. I am not sure that he would be a better engineer.

But however desirable such a combined course may be, it is not possible at present to make the whole or a part of a college education a requisite for admission to the technical schools. In 1902 there were graduated about 1,600 engineers; there was a demand for about 4,000. If a college diploma were required for admission, the number of graduates would not be more than a quarter as large as now. Even if it were possible to make such a requirement, I do not think it would be wise to do so. Whatever may be our opinion in regard to the best course of study, we must take into account the wishes of the student and the average technical student does not wish to go to college. He thinks the course of study too long and too expensive. He would be forced to give up all hope of an education if six or seven years were necessary to obtain it. A man's first duty is to make a living for himself and for those dependent upon him. The average boy—your boy and mine—has his own way to make in the world. He will be given an education but after that he must take care of himself. The technical course, if understood, is wonderfully attractive to the boy. The Talmud says, 'the end of learning is doing'; the end of a technical course is doing and the average boy wants to do something. He knows he can make a living as soon as he graduates. It is not strange that he wishes to begin this work as early as possible and to finish it as soon as consistent with thorough preparation for professional duties.

In conclusion I would say that the technical school has three great duties to perform in education.

First: To maintain a high standard in its professional teaching. It was created to do this work. Technical training is education of a high order, although not liberal. The mistakes of the engineer are destructive to property and sometimes to human life; hence the standard of teaching should be high.

Second: To see that it does not degenerate into a trade school. The student will go into practical work when he graduates and so there is a tendency to give him more and more practical work in the school. There is no objection to this, provided it does not interfere with the broader studies already described. If the liberal studies

usually given are dropped, the technical school will become a mere shop or drafting room.

Third and last: To encourage those young men who are planning to enter technical work to first obtain a broad and liberal training to the end that they may be better citizens and wield a greater influence in society, the community and the state.

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THE WORK OF THE BUREAU OF GOVERNMENT LABORATORIES, OF THE PHILIPPINE ISLANDS.

IN an article published in a former number of SCIENCE* a short résumé of the plan which had been devised to further scientific work in the Philippine Islands was given, together with an outline of what the bureau of government laboratories expected to do in the future. At that time the organization had only begun, and the scientific work which was being performed was limited. Plans for a new building were under way, and an attempt was being made to obtain a large corps of scientific workers to carry on the necessary research work for the government, but only a few men were actually on the ground. Two years have now elapsed, and it is possible to speak with certainty of the results accomplished, and with confidence of the scientific scope of the future.

The new laboratory structure, planned carefully in the beginning, is now approaching completion, and the adaptation of this building to the needs of the varied scientific work to be carried on can be appreciated. The branches of chemistry, bacteriology, pathology, botany, entomology, as well as the preparation of prophylactic and curative serums, have been amply provided for. Although it can already be said that each room will be occupied, there will, nevertheless, be no crowding for years to come, and only two or three workers on specific subjects will need to occupy one room at a time. The building has been somewhat delayed, not only owing to uncertainty as to its location, but also because of lack of some of the materials necessary for its construction. The machinery which is being installed will be ample for the purposes of laboratory technique. It will supply compressed air, vacuum, steam and steam exhaust, as well as electric power in all of the rooms and at all of the desks where such aids are necessary, and the pressure, mechanically provided, will give an ample water-supply for all parts of the building.

One difficulty encountered in laboratory work in the Philippine Islands has been in the gas-supply. Owing to the nature of oriental coals, it has not been profitable to construct municipal gas plants. The price of the coal which can be obtained is high, and the products are not such as to yield large quantities of illuminating gas, and obviously the importation of the proper materials from Europe or the United States is out of the question. Gasoline, which is used so frequently for laboratory supply in other countries, is both expensive and of an inferior quality, and for this reason the bureau has adopted the method of preparing its gas from cocoanut oil. Heavy cast-iron retorts are heated to redness in furnaces, and cocoanut oil is then slowly dropped in. The product is a very high quality of illuminating gas with very little tar and a proportionately small residue in the retort. In the new building a battery of three of these generators will be installed, and provision will be made for the putting in of a fourth unit, the capacity of the gas-holders being 2,500 cubic feet.

The bureau, as at present organized, is separated in three buildings, one for the work in chemistry and botany, another for

* SCIENCE, October 10, 1902.

biology and the allied work, including entomology, and the third in conjunction with the preparation of serums. The aim of these various divisions has been not only to provide for the immediate necessities in the way of chemical analysis, diagnostic work for the hospitals and prisons, and the preparation of prophylactic serums, for which an urgent demand existed, but it has also endeavored by its research work and publications to help the government in its knowledge of existing conditions, and to point out methods for advancement, not only in matters of hygiene, but in the development of natural products and in the study of diseases of men and of animals.

As is well known, one of the most serious problems which confronted the government of the Philippine Islands was the loss entailed by diseases of draft animals, which in times past has been so serious as practically to paralyze agricultural industries in certain districts. The laboratories were called upon, not only to give advice as to the best means of preventing the further spread of these disastrous maladies, but also to prepare for the elimination of dangerous contagious diseases where they existed. Therefore, in January, 1903, as soon as the serum laboratory was organized as part of the bureau, an insistent effort was made to prepare larger quantities of rinderpest serum, and to gather a corps of veterinarians with their assistants, who would be able to visit all parts of the archipelago for the purpose of inoculating against rinderpest the herds still remaining.

From a small beginning, with a few animals, the rinderpest serum herd has been increased to a number varying from fifty to seventy-five animals, according to the needs of the service, and a steady supply of non-immunes for the purpose of furnishing virulent blood has been obtained from Shanghai. The demands have been very large, for not only has serum been furnished to the veterinarians in the islands, but when the government decided to purchase inoculated draft animals in China for the purpose of restocking the islands, the burden of the immunization and hygienic care of the animals upon their arrival in Manila at first was thrown entirely on the laboratories, and the shipping of at least one half the necessary serum to Shanghai has been undertaken throughout the life of the contract.

The results in the islands have been most gratifying. The veterinarians have met with invariable success wherever they have gone, and the conditions have become such that rinderpest is non-existent in by far the greater number of provinces, and it is easily controlled in a short time wherever it reappears. The method of immunization used has been that of simultaneous inoculation.

The demand for vaccine virus has been very great, and the laboratories have been compelled to purchase a large number of calves for this purpose. These animals have, as a rule, when their quality would warrant, been sold to inhabitants intending to engage in the raising of cattle,* and in that way, after having been used for vaccine purposes, they are of continued benefit in the restocking of the archipelago. Of course all of these animals are immunized against rinderpest before leaving the institution. Plague prophylactic has been supplied to the board of health in quantities sufficient for all purposes, and its effectual use has been one factor in bringing down the number of plague cases to such a degree that the Philippine Islands may now be declared to be practically free from this disease. The rats caught by the board of health were examined for plague in the biological laboratory, and the results ob-

* Tuberculosis has never been encountered in examining the calves used at the laboratory.

tained were used in locating plague houses.

The cholera epidemic, which began on March 20, 1902, and which was in the ascendent for six months, naturally threw a large burden of work especially on the biological laboratory, whose etiological studies, diagnoses and autopsies were the basis of action by the board of health. The large amount of routine work entailed thereby interfered with extensive investigations in the bureau, but the results have warranted the time expended.

The attention of the biological laboratory has also been devoted to surra, a disease generally attacking horses, and which has caused many deaths in the islands. The extensive investigations of the bureau in this direction have been published in a monograph. The results, just as in the history of past efforts in this direction, did not lead to a method of cure, but they have nevertheless extended our knowledge so as to prove that the disease may be harbored by rats and transferred by lice and flies, that it is not conveyed by food, and the researches have led to advice as regards detection of affected animals and their destruction. It has also been shown that the native water-buffalo, termed carabao, is very susceptible and must be considered as an important factor in the extension of the infection. Surra infection has been one of the greatest difficulties encountered in the importation of draft animals from China, and the isolation of large herds and the endeavor to prevent its spread has been a task of no little magnitude.

The biological laboratory has also undertaken investigations on the all-important subject of human diseases, and is now preparing for publication work on a method of protective inoculation against Asiatic cholera and on amœbic dysentery, and it has been fortunate enough to encounter and describe some new diseases. Research on beri-beri, plague, cholera, trypanosomiasis, etc., is also in progress.

The veterinarians and inoculators of the insular government, with the exception of the ones necessary for actual laboratory work, have now been placed in a corps of veterinarians under the direction of the board of health, of which body the superintendent of government laboratories is a member, so that in the future the laboratories can, to a much greater extent, assume their normal function of furnishing prophylactic serums and diagnostic work, while the actual details of inoculation, isolation and destruction of infected animals will become part of the duty of the board of health. By this improvement the directors of the biological and serum laboratories and the employees in those divisions will be able to devote a larger amount of time to investigation and research in the lines which properly fall within their scope.

As the policy of the government was to provide laboratories which would be of maximum usefulness to the people, it was decided more than a year ago to permit the general public to call upon the bureau for analytical and diagnostic work at reasonable and fixed charges to be imposed in return for the results obtained. This privilege has been taken advantage of by the public to a considerable extent, and a large variety of work has come to the bureau as a consequence. The other bureaus of the government, such as the custom-house, bureau of agriculture, bureau of mines, etc., have occasion to use the laboratory very frequently to obtain analytical results of all kinds, and as a result the chemical laboratory has gradually developed a corps of analysts who are accurate, careful and capable of handling the work. In addition an endeavor has been made to begin systematic investigations, and the first results of such endeavor have appeared in a bul-

letin published by the bureau on the subject of 'India-rubber and Gutta-percha.' At the same time work has been steadily carried on in relation to the important cocoanut-oil industry, and results are gradually being obtained which in the near future will warrant the publication, from the commercial side, of accurate and complete information.

The field in the islands is very large and many topics remain to be handled. Especially is this true of many of the medicinal plants of the islands, of which very little is known, of the gums and resins, and of essential oils.

The corps of botanists, now consisting of four men, has, as is necessary in a new country, been devoting its first attention to the preparation of an adequate herbarium, and the collection now contains over ten thousand numbers. Materials have been sent to various countries for identification, but with the laboratory facilities now on hand much of this work is being done here. The time will soon come when this herbarium will have assumed sufficient dimensions to warrant individual investigations with it as a basis, and in furtherance of this plan the laboratory, in conjunction with the forestry bureau, will establish a botanical garden at Lamao, across the bay from Manila. When this is accomplished, the field of work will be open for the plant physiologist and mycologist and work can be steadily pushed. The results of the botanical work up to the present have been published in two bulletins, with a third in the press. The entomologists have been more handicapped in their work of identification than the botanists, as the field in the islands is practically new, and the species and genera obtained are, to a large extent, undescribed. The work of securing an adequate collection has been steadily pushed, however, and at the same time the economic side has not been lost sight of. So far the entomologists have published two bulletins, one on 'Insects attacking the Cacao Plant,' and another on the 'Australian Cattle Tick,' which is present in the islands and capable of transmitting Texas fever.

The library has steadily expanded, and although difficulty has been encountered in obtaining complete sets of some publications, the chief ones in all scientific branches now represented in the bureau have been purchased and are on the shelves, so that literature for extensive research work is available.

In all, the progress for the past three years has been most satisfactory, and the wisdom of the government in establishing one central laboratory institution, which could carry on all lines of necessary work, has been justified. In the place of a number of poorly provided laboratories, we have a bureau which is well equipped and prepared for its work. The individual scientific worker need not be isolated at some point where intercourse with his fellows is difficult or impossible, but he finds himself in a scientific atmosphere and in contact with students of all branches, giving him a broader and more satisfactory career and bringing to the government better results. In addition to these advantages, a place is provided for visitors of scientific training, where they may learn what has been going on, and may, if they desire, carry on investigations of their own.

The serial publications of the bureau, so far, comprise twelve numbers with two more in press, and the topics which have been covered demonstrate the value of the work. The list is as follows:

Biological Laboratory. 'Preliminary Report of the Appearance in the Philippine Islands of a Disease Clinically Resembling Glanders,' by R. P. Strong, M.D.

Chemical Laboratory. 'The Preparation of Benzoyl-acetyl Peroxide and its Use as an Intestinal Antiseptic in Cholera and Dysentery' (preliminary notes), by Paul C. Freer, M.D., Ph.D.

Biological Laboratory. 'A Preliminary Report on Trypanosomiasis of Horses in the Philippine Islands,' by W. E. Musgrave, M.D., and Norman E. Williamson.

Serum Laboratory. 'Preliminary Report on the Study of Rinderpest of Cattle and Carabaos in the Philippine Islands,' by James W. Jobling, M.D.

Biological Laboratory. 'Trypanosoma and Trypanosomiasis, with special reference to Surra in the Philippine Islands,' by W. E. Musgrave, M.D., and Moses T. Clegg.

I. 'New or Noteworthy Plants.' II. 'The American Element in the Philippine Flora,' by Elmer D. Merrill, botanist.

Chemical Laboratory. 'The Gutta-percha and Rubber of the Philippine Islands,' by Penoyer L. Sherman, Jr., Ph.D.

'A Dictionary of the Plant Names of the Philippine Islands,' by Elmer D. Merrill, botanist.

Biological Laboratory. 'A Report on Hemorrhagic Septicæmia in Animals in the Philippine Islands,' by Paul G. Woolley, M.D., and J. W. Jobling, M.D.

Biological Laboratory. 'A Report on Two Cases of a Peculiar Form of Hand Infection, due to an Organism resembling the Koch-Weeks Bacillus,' by John R. McDill, M.D., and Wm. B. Wherry, M.D.

Biological Laboratory. 'Preliminary Bulletin on Insects of the Cacao,' by Charles S. Banks, entomologist.

Biological Laboratory. 'Report on Some Pulmonary Lesions produced by the Bacillus of Hemorrhagic Septicæmia of Carabaos,' by Paul G. Woolley, M.D.

Biological Laboratory. 'A Fatal Infection by a hitherto undescribed Chromogenic Bacteria-Bacillus Aureus fœtidus,' by Dr. Maximilian Herzog.

I. Serum Laboratory: 'Texas Fever in the Philippine Islands and the Far East,' by J. B. Jobling, M.D., and Paul G. Woolley, M.D.

II. Biological Laboratory: 'On the Australian Cattle Tick—*Boophilis Australis*,' by Chas. S. Banks.

PAUL C. FREER.

BUREAU OF GOVERNMENT LABORATORIES OF THE PHILIPPINE ISLANDS.

SCIENTIFIC BOOKS.

The Nature of Man; Studies in Optimistic Philosophy. By ELIE METCHNIKOFF. English translation, edited by P. CHALMERS MITCHELL. 1 vol. in 8°, pp. xvi + 302, with author's portrait and twenty illustrations. New York and London, G. P. Putnam's Sons. 1903.

In 'The Nature of Man,' Elie Metchnikoff, a Russian professor at the Pasteur Institute, in Paris, presents a valuable contribution to scientific philosophy.

The book is addressed to 'disciplined minds, and especially to biologists.' It is not, the author states in the preface, so much a finished study as food for further thought and investigation, a program of work. But it reaches beyond this. It deals principally with the numerous imperfections and disharmonies in the human constitution and functions, with old age, with the vital instincts and with death.

Man is a comparatively recent and possibly accidental descendant of some anthropoid ape and has differentiated from his ancestors principally through his brain. There are many parts of his constitution that have not kept the same pace in evolution; as a result, man's organism is not throughout harmonious and equally adapted to his present circumstances, which affects adversely his health, happiness and duration of life.

Man is still covered with hairs, though they are no longer needed or capable of protecting his body from cold, and their follicles offer easy lodgment to microbes, which give rise to acne, or even worse forms of skin affection.

The wisdom teeth furnish an instance of disharmony. They are not only nearly useless, but often become a source of trouble that in exceptional cases leads to disease or even death.

The vermiform appendage is another organic disharmony, serving no useful purpose, but often the source of great disorder and danger to life.

Degenerating organs in the human body, such as the cæcum, exhibit disharmony. In fact, the whole of our large intestine is largely superfluous. It is of secondary importance to

digestion and absorption. The loss of a large part of it could easily be endured by man. On the other hand, it is a source, through autointoxication, and diseases peculiar to it, of much danger to man's health and life.

There are disharmonies in our organs of sense, and, particularly, in the organs and functions of reproduction; and there are disharmonies in our instincts as well.

Senility should be a natural, physiological phase of man's existence, but as it exists, it is to a large extent a pathological condition. The fundamental organic change in senility is the atrophy of the higher and specific cells of our tissues and their replacement by hypertrophied connective tissue. A very important destructive rôle in the process is played by the cells known as macrophags. The degeneration of the higher cellular elements and facilitation of the work of the macrophags is aided by all agencies that weaken the organism. Among such stand foremost the poison of syphilis, alcohol and the products of intestinal fermentations.

As to death, we are so accustomed to look upon it as something natural and inevitable, that it has long since come to be regarded as inherent in organisms. This has been disproved by biology. Low, particularly unicellular, organisms, are not subject to the natural death that comes inevitably to man and higher animals. There are even somewhat higher organisms, such as many polyps and some worms, to which natural death does not come; these animals divide indefinitely into new individuals. Hence, death is not necessarily inherent in living organisms. Even our own bodies contain elements practically immortal, the spermatozoa and ova. Natural death in man is probably a possibility rather than an actual occurrence. Old age, as it exists, is not a true physiological process, but exhibits many morbid characters. That being the case, it is not surprising that it seldom ends in natural death.

Would the appearance of natural death in man be accompanied by the disappearance of the instinct of self-preservation and the appearance of another instinct—that of death? To this the author has no exact answer; yet he adduces some testimony favoring that view. It is well known that the instincts of hunger, thirst, movement, etc., allied to those of desire of life and fear of death, often change with age. The instinct of death seems to lie, in some potential form, deep in man's nature. If human life followed its ideal course, fulfilling all its physiological functions, then the instinct of death would appear in its time, after a normal life and an old age healthy and prolonged. As it is, old men die in morbid old age and in the fear of death, without having known the instinct of death, and this constitutes the greatest disharmony of human nature. The goal of existence is the accomplishment of a complete and physiological cycle, in which occurs a normal old age, ending in the loss of the instinct of life and the appearance of the instinct of death. The normal end, coming after the appearance of the instinct of death, may truly be regarded as the ultimate goal of human existence. But before attaining it a normal life must be lived: a life filled all through with the feeling that comes from proper accomplishment of function.

What is to be done? Before all things, it is necessary to try to amend the evolution of human life; that is to say, to transform its disharmonies into harmonies. This can be undertaken only by science, and to science the opportunity of accomplishing it must be given. We must know the human constitution thoroughly, must understand the most intimate details of its mechanism. In the problem of his own fate, man must not be content with the gifts of nature; he must direct them by his own efforts. Just as he has been able to modify the nature of animals and plants, man must attempt to modify his own constitution, so as to readjust its disharmonies.

As will be plain from this brief reference, Metchnikoff's 'Nature of Man,' notwithstanding its slightly misleading title, is a dissertation on some of the most important phases of man's natural history. It is a work remarkable for its simple language and clear style. It is not, as the author admits, a finished work, but it is a well advanced one.

There are a few points which are open to

argument, especially that of the significance among mammals of the large intestine.*

But on the whole the work bears the stamp of a production of an erudite scientist and a deep thinker.

ALEŠ HRDLICKA.

U. S. NATIONAL MUSEUM.

Die Chemie der Zuckerarten. Von Professor Dr. EDMUND O. VON LIPPMANN, Director der Zuckerraffinerie Halle zu Halle a. S. Dritte völlig umgearbeitete Auflage. 1904. Braunschweig, Friedr. Vieweg und Sohn. Gr: 8vo. Pp. xl + 2003. In two volumes. Price, M. 30; bound, M. 34.

This work, the third edition of the prize essay 'Die Zuckerarten und ihre Derivate,' which first appeared in 1878, embodies the sum total of our present-day knowledge of the sugars.

So great has been the progress made and the wealth of material accumulated in this field of research within the past decade that the contents of this work fill fully two thousand pages; for the sake of convenience the publication is issued in two volumes.

The first of these volumes contains the introductory remarks, a copious table of contents and a full discussion of the monosaccharides. The second treats of the di-, tri- and tetrasaccharides, the constitution, configuration and synthesis of the sugars, the relations between the optical, caloric and other physical constants, the origin of the sugars in plants, and of the physiological importance of the sugars. In addition to this there are the addenda, bringing the discussion of the subject matters up to the close of February, 1904; an author's and a subject index—the latter alone covering about fifty pages.

When one recalls the various domains of knowledge with which the chemistry of sugar is necessarily in touch and contact, for instance general, organic, analytic, physical, physiological, medical, pathological chemistry, the chemistry of foods, of fermentation, bacteriology, agricultural chemistry, physics, etc., a faint conception may be formed of the gigantic task which confronted the author in his endeavor to deal adequately with his subject.

Of course, certain limits had to be set, the lines of demarcation had to be drawn somewhere, and of this no one could have been more clearly conscious than the author. With a modesty as charming as it is rare, he states in his preface: 'Completeness could not be attained in any direction,' and yet this work is the most thorough of all works ever published on the chemistry of the sugars.

The fundamental idea governing its whole scope and plan is the giving of a detailed description of the various kinds of sugars and their more immediate derivatives, while less closely allied bodies receive attention only to an extent necessary to define and establish their characteristics.

Instead of entering into a detailed account of the well-nigh innumerable methods of analysis and technology, the author has sought to give their essence and spirit, to sketch in clear outlines their underlying principles. Data relating to the construction and manipulation of polariscopes, to the specific gravity of sugar solutions, etc., data which can readily be found in manuals and text-books, have been omitted.

Scheibler's naming of the sugars has been retained, the author deeming the time not yet come for the adoption of Emil Fischer's rational system of nomenclature. A noteworthy feature of the book is the manner in which the table of contents and the index complement each other, the former referring to the general topics, while the index lists the individual chemical terms and expressions.

Space, of course, forbids here entering upon a detailed review of these volumes; all that may be done is to sum up in a few words the impression left by a careful, critical examination of their pages. The style in which the book is written is attractive—concise, clear, forceful. There is no question but that von Lippmann in his 'Chemie der Zuckerarten' has given to chemical science a monograph

* Metchnikoff considers that, in the active mammalian life, 'the need to stop in order to empty the intestines would be a serious disadvantage' and implies that this factor may have had influence in the evolution of the organ.

which in thoroughness, lucidity, in masterly treatment throughout, is rivaled by but few, excelled by none. F. G. WIECHMANN.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Botanical Gazette* for June contains the following articles: Dr. Roland Thaxter publishes a further contribution on the Myxobacteriaceæ, especially in reference to the work of Migula, Zukal, Miss A. L. Smith and Zederbauer; also establishing eight new species. John Donnell Smith contributes his twenty-sixth fascicle of 'Undescribed Plants from Guatemala and Other Central American States,' describing twelve new species. Thomas H. Kearney asks the question, 'Are Plants of Sea Beaches and Dunes True Halophytes?' reaching the conclusion that these are not generally halophytic. Alice Eastwood publishes fourteen new species of western Polemoniaceæ. George J. Peirce, in 'Notes on the Monterey Pine,' shows that the difference in the quantities of water and solutes drawn up through the xylem into galled and normal leaves furnishes the reason for the differences in the amount of conducting tissue as shown by the annual rings. In other words, amputated seedlings and branches bearing galled leaves develop bundles which vary from the normal according to the degree of injury which the leaves have undergone. This is confirmation of Jost's conclusion that leaves and vascular bundles are closely correlated in their development. Amon B. Plowman publishes the 'Celloidin Method for Hard Tissues' as developed and perfected by Professor E. C. Jeffrey. M. A. Chrysler publishes 'Anatomical Notes on Certain Strand Plants,' being the results of a comparative study of the leaf anatomy of certain plants in the vicinity of Woods Hole and near Lake Michigan. Charles E. Allen makes a preliminary announcement of his conclusions in reference to chromosome reduction in *Lilium canadense*, being quite different in some points from those previously maintained.

THE June issue of the *Bulletin of the Michigan Ornithological Club* contains the following articles: 'Some Notes on the Life History of the American Redstart,' by J. Claire Wood, with a full-page cut of the species by Louis Agassiz Fuertes. Bradshaw H. Swales concludes his 'List of the Land Birds of Southeastern Michigan.' A. H. Griffith contributes 'Birds in Decoration,' which is illustrated by specimens of Japanese art from the Detroit Museum of Art. P. A. Taverner writes on the 'Tagging of Birds' as a means of solving some of the vexing problems of migration. Walter B. Barrows describes the ornithological and oological collections of the Michigan Agricultural College, which is supplemented by a half-tone of the interior. Alexander W. Blain, Jr. notes the capture of 'Three Rare Michigan Birds.' There are other notes of value and the usual reviews. With this issue Professor Barrows becomes one of the editorial staff.

SOCIETIES AND ACADEMIES.

THE RESEARCH CLUB OF THE UNIVERSITY OF MICHIGAN.

AT the meeting of the club held April 27 Dr. Novy presented the results obtained in collaboration with Mr. McNeal on the cultivation of the organisms causing trypanosomatic diseases. These investigators have been able to cultivate three of these protozoa. The organism *Trypanosoma lewisi* has now been under cultivation for two years. *T. brucei*, the cause of nagana or the tsetse-fly disease of South Africa, has been under cultivation since last August. The culture medium sent from Manila, after inoculation with the trypanosome from a cow suffering with surra, on arrival in Ann Arbor, showed an excellent culture of this organism which had developed en route. This organism was kept alive for sixty-five days, but all efforts to secure infection in animals or to obtain subcultures failed.

A comparison of the trypanosome from the Philippine surra with that from the Island of Mauritius seems to indicate that the two are entirely distinct.

The cultural characteristics of the Philippine trypanosome are such as to distinguish

it readily from *T. brucei*, the cause of the South African tsetse-fly disease. This confirms the work of Laveran and Mesnil on the non-identity of these two diseases and effectually disproves the view held by some that the various trypanosomatic diseases are due to one and the same organism.

The culture of *T. brucei* is nearly but not quite as virulent as the material from an affected animal. Such virulent cultures, developed at room temperature or at 25° C., when placed at 34° C. for two days lose their pathogenic properties; and by means of such attenuated cultures it is possible to immunize a guinea-pig. This fact is of importance, since it may have a bearing upon the prevention of these diseases.

It was further shown that cultures of *T. lewisi* at times contain very minute forms of the organism and that when such material is passed through a Berkefeld filter the resultant filtrate on inoculation into rats produces a typical infection. This goes to show that even a large protozoon may have a sufficiently small form, even if it is not ultra-microscopic, which can traverse the pores of a filter.

Dr. Novy was followed by Professor Lloyd, who read a paper on 'The History of Ethics.'

The last meeting of the year was addressed by Dr. J. E. Duerden, who gave an account of his researches on the morphology and development of recent and fossil corals, and by Dr. Geo. A. Hulett, who read a paper detailing the results of his work on standard cells.

The latter paper showed that the hydrolysis of mercurous sulfate (Hg_2SO_4), the depolarizer, has been worked out, and the effects of the hydrolytic products of the electromotive force of the cadmium cell determined. The author's method of preparing electrolytic mercurous sulfate was described, as well as methods of preventing hydrolysis in the setting up of the standard cells. The results indicate that the cells are reproducible with a variation of but a few parts in 100,000. The details will soon be published in an article on 'Mercurous Sulfate in its Relation to the Standard Cells.'

FREDERICK C. NEWCOMBE,
Secretary.

THE TORREY BOTANICAL CLUB.

THE club met April 27, 1904.

The first paper of the scientific program was by Dr. N. L. Britton, on 'Explorations in Florida and the Bahamas.' This was illustrated by maps and specimens, and described the general features of the flora of the region of the part of subtropical Florida south of Miami, to which a visit of three weeks' duration was made in March and early April with Mrs. Britton and Dr. M. A. Howe, in cooperation with Professor P. H. Rolfs, of the U. S. Subtropical Laboratory. A detailed account of the flora was not taken up, inasmuch as Dr. John K. Small, who explored the same region last autumn, and who will again visit it in May, proposes to publish a complete account of the material secured. Two genera, new to the continent, both represented in Florida by a single species, were discovered, *Alvaradoa* in hammock lands and *Sachsia* in pine lands, both of these genera existing also in Cuba and in the Bahamas.

Dr. C. F. Millspaugh, of the Field Columbian Museum, joined the party early in April, and the Island of New Providence in the Bahamas was partially explored. The distribution of plants of this island was described, the littoral zone containing many common West Indian and Floridan species, of which the most characteristic are, perhaps, the shrubs *Jacquinia Keyensis* and *Salmea petrobioides* the latter endemic in the Bahamas.

Between the littoral zone and the interior regions of the island there is in places a plant society, which may be termed an intermediate one, characterized by such shrubs as *Buxus Bahamensis, Banara reticulata, Calliandra formosa.*

The pine lands (*Pinus Bahamensis*) contain among other species, *Pteridium caudatum, Vernonia Bahamensis* and *Byrsonima lucida,* as characteristic species. The palmetto lands (apparently *Inodes Palmetto*) contain more herbaceous vegetation than the other regions including *Linum Bahamensis, Sachsia Bahamensis* and *Sabbatia campanulata,* though also having a considerable number of shrubs. The 'coppets' or 'hammocks,' as they are called in Florida, are areas devoid of either pines or

palmettos and often occupy isolated areas entirely surrounded by pine forests as in southern Florida; characteristic trees of these hammocks are *Dipholis salicifolia, Eugenia confusa, Icacorea paniculata* and *Cocolobis laurifolia,* all of which occur in similar situations in Florida.

Dr. C. F. Millspaugh, who was with Dr. Britton and remained somewhat longer, was asked to discuss the paper. He reported that plants found in bloom at the center of the island were found in fruit at the west end, while at the east end, which is dry and rocky, the buds of the same species were scarcely started. South Bemini is much like New Providence in vegetation, though its elevation is less. A *Rhus* resembling *R. toxicodendron* was found on Cat Cay and there is an interesting palm on the same island.

Inquiry was made concerning *Croton Eluteria,* which is prized in West Indian countries as a bitter drug, but is said to be disappearing. The plant had not been seen, but a guide said that it grew on South Bemini.

Professor Underwood called attention to *Odontosoria clavata,* which in Jamaica and Cuba grows in very wet places and is a soft tender plant, while in the Bahamas what is apparently the same species grows in dry pot-holes and is firmer and stronger.

The second paper was by Dr. D. T. MacDougal on 'Desert and Delta Vegetation of Sonora and Baja, California.' The Colorado River has been called the Nile of America. It flows 600 miles without tributaries and has a delta 150 to 200 miles long by 50 to 100 miles broad. In this region is the most pronounced desert in the United States and probably in America. The topography of the region may be described as a great basin with the Colorado River flowing along the eastern margin. The Salton basin is 400 feet below sea level and in times of unusual flood is transformed into a great lake by overflow of the Colorado River, the last such flood occurring in 1891, when part of the track of the Southern Pacific Railroad was under water. At one point in this basin there has been an elevation of mud volcanoes from ten to fifty feet high, where there are hot sulphur springs. The dry season is from August to April or May. At the end of the wet season the Indians dig holes deep enough to get into and plant their corn and melons in these. The surface of the ground becomes very dry, but enough moisture is retained to mature the crops. Within a few yards of the river channels relative humidities of eleven, twelve or thirteen per cent. were observed. The temperature of the summer flood water is 45° to 55°, while the air temperatures are the highest to be found in the country, 100° to 125°. At the lower end of the delta is a region of brackish water.

Distichlis spicata is widely distributed on the mud flats; the Mexican poplar, an unidentified willow and the mesquite were the trees observed, while the arrow-weed forms almost impenetrable thickets. Within the width of a few yards one passes from river vegetation to true desert.

Ammobroma Sonoræ, described by Torrey, has a stem two to four feet long, all buried except the head. It is parasitic on *Atriplex* roots. A puff ball with the same form and similar appearance was found, but it was too brittle to stand carrying.

The east coast of Baja, California, near the head of the Gulf, is supposed to be the driest spot in America. One half inch of rain only has been recorded at Yuma during 1903, and Palmer visited an island in the gulf in 1889 which had no rain for a year and a half. Landings were made at three points, the farthest at San Felipe Bay, 55 miles below the river. Mr. Brandegee visited San Luis Bay once, but the San Felipe region was entirely unexplored by botanists. Here the coast rises by gradual slope to 500 feet and then by precipitous rocks to peaks, one of which is over 10,000 feet high. The seasons are evidently irregular and not clearly marked. Many of the plants have milky or resinous juice and many are aromatic. *Cereus Schottii* was found forming dense groves near San Felipe. Living plants of what is probably *Cereus Pecten-aboriginum* were brought home. The Indian-comb cactus has a short trunk and long branches in contrast to the usual form of *C. giganteus.*

Although the plants are very sparse it is not

to be supposed that they have a harder struggle for existence than others, as is shown by trying to grow them under artificial conditions. *Fouquieria splendens* seems to reach its optimum development in the delta lands. Cactuses with sheathing spines were noted and some of these shed their spines. The flora is not Arizonian. In San Felipe there are no plants with storage organs, for there is no surplus of water to store.

In the discussion it was mentioned that the poison cacti are all unarmed.

Professor Underwood remarked on a specimen of the southern brake sent from Burlington, Vt. This form described in recent years as *Pteris aquilina* var. *pseudocaudata* by Clute, is the *Pteris latiuscula* Desv., described in 1827.

WILLIAM T. HORNE,
Secretary pro tem.

SCIENCE CLUB, UNIVERSITY OF MISSISSIPPI.

THE last regular meeting of the club for the year 1903–4 was held May 20 in the chemical lecture room.

Mr. H. R. Fulton read a paper the purpose of which was to give some account of the life histories and habits of the common mosquitoes. It was stated that of the thirty species of mosquitoes occurring in North America, ten have been found in Mississippi. Attention was directed particularly to three genera: *Culex, Stegomyia* and *Anopheles*. The first was said to be the most numerous and widely distributed, not, however, transmitting disease, so far as known, and important chiefly because of the annoyance which it occasions. The second, found in many of the southern states and flourishing in the tropics, was charged with being certainly instrumental in the transmission of yellow fever. The last, also widely distributed, was said to convey malaria.

The four distinct stages—egg, larva, pupa, adult—in the complete metamorphosis through which every mosquito passes in its development were fully treated, as, also, the peculiarities of size, shape, markings, movements, etc., which differentiate the three genera.

Length of flight, local breeding places and the methods used by the author of the paper in attempting to check and exterminate mosquitoes in this vicinity were discussed.

In speaking of the movements of the larva of *Culex*, Mr. Fulton stated that he had observed a movement of which he had found no mention, this being in a horizontal plane, taking place as the larva moves under the surface or over the bottom or through the intermediate water, unaccompanied by violent body-movements, and probably caused by rapid vibrations of the numerous hair-like processes covering the body.

Dr. J. B. Bullitt added some remarks on those mosquitoes which transmit malaria and yellow fever.

ALFRED HUME,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A CASE OF PLAGIARISM.

TO THE EDITOR OF SCIENCE: In a note on 'The Mechanism of the Mont Pelée Spine' (SCIENCE, June 17, 1904), I say: 'So far as the literature has come to my attention, it has failed to include a factor which appears to me of prime importance,' etc. Through this sentence I claim originality, and presumptive novelty, for an idea which I now know not to have been novel, and think not to have been original. The idea was published six months earlier by Dr. A. C. Lane in a note on 'Absorbed Gases and Vulcanism' (SCIENCE, December 11, 1903). It is not necessary, in dealing with my friend Dr. Lane, that I disclaim intentional plagiarism, but, as I find interest in the mental process of my blunder, I venture to relate what I suppose to be its history. It is altogether probable that I read Dr. Lane's note when it appeared, but the mental impression it made was so faint that in re-reading it now I can not definitely remember seeing it before. Nearly a half year later an idea as to the Pelée spine occurred to me and I wrote it out for publication. While I supposed the idea original, there was in my mind a faint suspicion that the suggestion might have come from some outside source, and this suspicion led me to search all the literature of the spine that I could recall having seen—but I did not recall that Dr. Lane had made a contribution. Thus a

mental impression too faint for complete identification, now that attention is directed to it, nevertheless rose into consciousness with the semblance of a spontaneous idea, and gave rise to a distinctly plagiaristic publication.

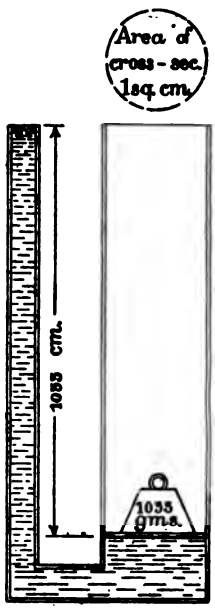
G. K. GILBERT.

SAN FRANCISCO,
June 28, 1904.

SPECIAL ARTICLES.

THE ASCENT OF WATER IN TREES.

RECENT discoveries by Vesque and E. B. Copeland and others have brought us very near the solution of this inveterate problem; but botanists seem agreed to halt at the last



Hydrostatic Paradox.

step, awaiting some occult signal from the physicists. The old toy of the 'hydrostatic paradox' ought to teach them that water pressed upwards by the atmosphere has no divine right to call a halt at 1,033 centimeters. One fluid may support and also elevate another fluid to any required height. Thus the supported weight in the annexed diagram may be represented by a column of water raised a mile high or more. The condition is that there shall be no immediate continuity of mass between the fluid to which the atmospheric pressure is applied, and that which is to be lifted. This condition is secured in the tree by the numerous transverse septa on its water-ducts, which prevent the transmission of air or water in mass, but permit a very free molecular diffusion of water, and of everything dissolved in it.

Assuming the diameter of a water-duct to be half a millimeter, it is easy to estimate the weight supportable by a septum at its base; seeing that its upward parts are protected from other atmospheric pressure. The area of the cross-section of the basal part, in centimeters, if multiplied by 1,033 (the height in centimeters of a column of water equaling the atmospheric pressure), gives 2.028 cubic centimeters, or the same number of grams, as the load which the basal septum can support. This load may be a column of water filling the whole duct for a height of 34 feet, or it might be a column or stream of water twelve times as high and only one twelfth as large in cross-section. If the duct were filled with one part of water and eleven parts of air, the water and air together should be supported by the atmospheric pressure at the base to a height of about 403 feet. Assuming that there were in this course about 90 cross-septa, approximately equidistant, we should have a fall of pressure with each succeeding stage, equivalent to about one third of an inch of the mercurial barometer, reaching zero at the summit.

The mechanism in the xylem-ducts, however, can not be of this kind; because not only would the gas-bubbles obstruct the current if they came between it and the walls, but the spreading out of the pressure of the ascending current over the septa would cause the 'hydrostatic paradox' to work backwards with greatly increased force. This compels us to favor the view of interning the gas-bubbles within the water. Dr. MacDougal states that 'the cavity of a wood-cell contains a bubble of gas' ('Plant-Physiology,' p. 29). And Strasburger describes the water as freely streaming round the gas bubbles, or between them and the walls. This arrangement of water surrounding gas-bubbles constitutes what is

known as foam; not, indeed, of the rough kind, but 'dressed' so as to be in unison with the shape of the duct through which it must pass. It would take a great many hundreds of meters of such foam to weigh a kilogram to the square centimeter. Thus the atmospheric pressure at the base proves to be sufficient for the work to be done. Every change of equilibrium will cause a movement upwards of the water which is the only movable ingredient of the mixture.

If we are correct in accepting the observations that the water thus surrounds and encloses the continuous or beaded air-globules (which must also have much vapor of water) not only is the streaming of the water accounted for, but also such phenomena as capillarity and diffusion, and occasional stasis reminding one of the phenomena of capillary circulation of blood. Also the correlation which Strasburger, Vesque and others have observed between the state of the barometer and the streaming within the xylem-ducts is explained; and possibly the pulsation of gas-bubbles which MacDougal regarded as helping to raise the water upwards.

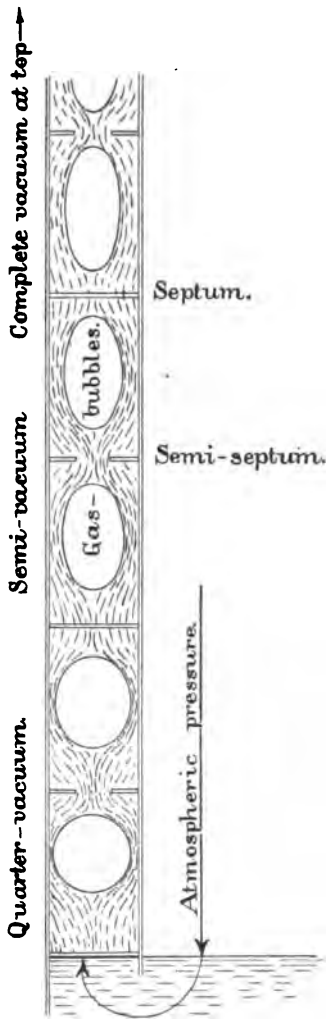
The condition of low apical pressure is secured by the activity of the leaves correlated with the structure of the ducts. The leaves are not known to actively attract the water, but they always remove it as it arrives, turning it into starch, and transpiring it in great quantity. When they die or are stripped, the ascent of water ceases (though at lower parts of the stem bleeding may be thereby induced). Also in the leaves and downwards the water-ducts are protected from direct atmospheric pressure by their structure, having spiral threads, and bars and thick walls to prevent compression, and having their very tips roofed over by domes. Their pits with thin membranes permit diffusion sideways, into other ducts or into parenchyma; and thus interchange is secured among the different elements. The machine will not work if the walls are torn, but if they are whole, their being dead does not obstruct their action. The fact that trees become stag-headed from a loss of water proves a delicate adjustment, especially as the different species have their differences of height and other idiosyncrasies relatively to the phenomenon.

The transverse septa of the water-ducts appear to us to play a leading part in the process. Transmitting the water by diffusion and intercepting the gases, they constitute a series of chambers each having a number of immobile air-bubbles, and permitting the water to flow between these by the only channel which it can take. We do not know how thick is the stream, otherwise than by the deductive method given above, but it probably varies in thickness and rapidity relatively to the height and leafage of the tree; very lofty trees having little leafage, and yet having many water-ducts. We think that the dynamical part of the problem is explainable mainly by the *vis a tergo* of the atmospheric pressure at the base.

The tracheids of the giant conifers exhibit the same principle, by their bordered pits with a torus which is centrally thickened and is overarched by diaphragms. The torus is a relatively large flexible membrane, which transmits the whole pressure, and at the same time limits the quantum of water that can find a passage upwards.

The air drops are not only obstructed by the septa, but they seem to keep apart within a section, as if we had a combination of the Jamin-theory with the osmotic functions of the septa. Each air-drop seems to have a shell which prevents its fusing with its neighbors, and thus the system becomes a sort of emulsion, like the fat-globules in milk. My colleague, Professor E. H. Loomis, who has aided me by criticizing the physical points, furnishes me with a striking illustration of this phenomenon. A bubble of air having got into one of his barometers, and being imprisoned between the mercury and the glass, he let in other bubbles. But these carefully avoided it; and when their course seemed to indicate collision and fusion, they turned aside and passed round it, escaping contact. Another colleague tells me of a case in Kansas where the lives of a community were saved during a drouth by a rotten pump which admitted air as well as water and raised the mixture about 40 feet after the other pumps had given out.

The second diagram represents the air-bubbles as gradually narrowing upwards. This accords with the theorem of Schwendener and Steinbrink, who held that the ducts are ex-



Xylem-duct.
(diagrammatic)

ceedingly narrow at their tips. The same result is given from observations on the red beech by Hartig and Weber. Strasburger had previously shown that narrow ducts contain very little air, and have streaming water; whilst large ducts in tall stems have much air and usually little water. If we accept these data we find an extraordinary correlation. Through the length of a lofty stem are wide tubes, whose contents are a column of froth of the lightest kind, having a maximum of air in a very thin shell of water. In the region of the leafy spray the conditions are reversed, narrow ducts and a relatively heavy load; and hence the need of a high vacuum, which is secured by the curious structure and the proximity of the leaves.

I am obliged to Professor MacDougal for referring me to Steinbrink's paper, and to Mr. Earle Anderson for drawing the diagrams.

George Macloskie.
Princeton University,
June 25, 1904.

BOTANICAL NOTES.

THE NUMBER AND WEIGHT OF COTTONWOOD SEEDS.

At my suggestion, one of my students, Mr. B. R. H. d'Allemand, made careful counts and estimates as to the number and weight of the seeds of the cottonwood (*Populus deltoides*). Selecting a well-grown pistillate tree about forty feet in height with a trunk two feet in diameter, and a spreading top fully forty-five feet from side to side, he carefully divided it by an imaginary vertical plane into two equal parts. One of these halves he divided again in the same manner, and continued the process until he reached a branch small enough to enable him to count the number of catkins which it bore. It was found in this way that the tree bore about 32,400 catkins. Then a number of careful counts were made of the seed pods in the catkins, by which it was found that the average number is about twenty-seven. The average number of seeds in the pods was easily determined by a series of counts to be thirty-two. From this it appears that this particular tree produced the enormous number of nearly twenty-eight millions of seeds.

One hundred seeds with their cottony fibers attached were then weighed upon a chemical balance. The result was .065 gram. So the weight of a single seed is .00065 gram, and the total weight of all the seeds on the tree 18.2 kilograms, or almost exactly forty pounds.

WEIGHT OF DANDELION-DOWN.

How heavy is a dandelion-down with its achene as it floats away on the breeze? The tiny parachute is so constructed that the weight of the achene brings the spreading rays at the summit of the slender rod (*rostrum*) into the proper position for floating in the air, as any one may readily see for himself by 'blowing' a seeding dandelion head in a quiet place. It makes no difference what the position of the parachute may be, as soon as it is free in the air the weight of the achene rights it at once. One who has not closely observed dandelions will be much interested in watching the quick 'righting' of every little parachute under the action of the tiny achene weight. Recently it occurred to me to find out how heavy dandelion-downs are, and at my suggestion Mr. d'Allemand undertook the delicate task of weighing them. He found that there are about one hundred and ninety achenes in each dandelion head, and, carefully counting this number, he determined their aggregate weight to be .085 gram. From this it was easy to calculate the weight of a single achene to be .00044 gram. It takes more than two and a quarter millions of dandelion-downs to weigh a kilogram, and somewhat more than one million to weigh a pound. In other words each parachute weighs about one millionth of a pound!

TENDRILS OF VIRGINIA CREEPER.

IT is pretty generally known nowadays that some Virginia creepers cling to walls by discoid expansions of their tendril tips, while others produce twining tendrils without such expansions. Among gardeners there is a pretty general notion that there are two quite distinct kinds, distinguished mainly by the presence or absence of disks. This distinction has even been admitted into recent descriptive manuals, as in Britton's 'Manual,' where the disk bearing form is called *Parthenocissus quinquefolia,* and a form with 'tendrils mostly without terminal adhering disks' is set off as the variety *laciniata.*

In a recent popular article Professor Pammel gives his opinion that this difference as to the formation of disks is not constant with any particular plant, and in a subsequent letter cites the case of the planting of a disk-bearing Virginia creeper which later formed ordinary twining tendrils only. On smooth surfaces the disks are not produced. This agrees with the statement made by Goebel in his 'Organography of Plants' (page 268, English edition) as follows: "Mohl was the first to show that the adhesive disks on the tendrils of certain species of *Ampelopsis* appear in consequence of contact with a firm body. We have here to do with a contact stimulus. Different species of *Ampelopsis* behave differently. Some, like *A. hederacea,* possess ordinary tendrils which twine round a support and eventually become firm, woody structures, but if they do not happen to find a support they die off at an early period. *Ampelopsis quinquefolia,* on the other hand, fixes itself to walls and tree trunks by means of adhesive disks on its tendrils, but these can also act like ordinary tendrils. In tendrils which do not come in contact with a firm body no viscid disks appear." Making allowance for some confusion as to the identity of the species, it appears that Goebel regards the formation of disks as a result of a mechanical stimulus. There is need of a number of careful observations on this point in connection with one of the most widely grown of all ornamental climbing plants.

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THE UNIVERSITY OF NEBRASKA.

FIELD WORK FOR 1904 OF THE DIVISION OF GEOLOGY AND PALEONTOLOGY OF THE UNITED STATES GEOLOGICAL SURVEY.

THE field work of the division of geology and paleontology, United States Geological Survey, for the season of 1904 will cover investigations in many states. Dr. C. Willard Hayes, geologist in charge of geology, has general supervision of this work. Some of the most important of the numerous parties in the field are here mentioned.

General Investigations.—Besides investigations confined to the limits of one or two states, several lines of work will be taken up that will cover wide general areas. The gla-

cial geology of the United States will be studied by Professor T. C. Chamberlin, who will have the assistance of Messrs. R. D. Salisbury, W. W. Atwood, F. H. H. Calhoun, Frank Leverett, W. C. Alden and F. W. Taylor. The glacial areas in the Rocky Mountain region will be carefully investigated by Professor Salisbury, assisted by Messrs. Atwood and Calhoun. A monograph on the Pleistocene formations of the lower peninsula of Michigan and adjacent portions of Indiana will be completed by Mr. Leverett. Mr. Alden will map portions of southeastern Wisconsin for folio publication.

The pre-Cambrian and metamorphic geology of the United States will be studied under the direction of Professor C. R. Van Hise, who will also complete his report on the geology of the Lake Superior region. In this work he will be assisted by Messrs. C. K. Leith and W. N. Smith. He is also directed to continue investigation of the metamorphic iron-ore deposits of the United States, particularly those of the Rocky Mountain and Great Basin region.

Other general investigations covering several states will be conducted by Mr. E. C. Eckel. He will complete a study of the cement industry of the United States and prepare a report in which special attention will be paid to the geologic and economic relations of the industry. Mr. Eckel will also complete an investigation of the slate industry of the United States, directing the work of Professor A. H. Purdue in Arkansas and Professor T. N. Dale in Virginia, West Virginia, Maryland, Pennsylvania, Maine and Vermont.

The Mississippi Valley.—Several states will be included in an investigation to be made by Mr. H. Foster Bain of the lead and zinc deposits of the Mississippi Valley. He will make a special study of their genesis, geologic occurrence and economic importance. His specific task is to examine the lead and zinc deposits of the upper Mississippi district in Illinois, Iowa and Wisconsin and to prepare a preliminary report upon this district. In addition he will examine certain copper deposits in Shannon County, Missouri, associated lead and zinc ores in St. Genevieve County and in the Mine Lamotte district, and the St. Clair and Granby mines in southwestern Missouri. He is also directed to reexamine the more important lead and zinc mines of the western Kentucky district and to make a reconnaissance examination of the lead and zinc district of the Appalachian Valley in Virginia and Tennessee. Mr. E. O. Ulrich, who is directed to investigate the Silurian and Ordovician paleontology and stratigraphy of the northern Mississippi valley, will cooperate with Mr. Bain in the study of the lead and zinc deposits of that district.

Alabama.—An areal and economic survey of the Brookwood quadrangle, Alabama, will be made by Mr. Charles Butts, who will be assisted by Mr. Hoyt S. Gale. They will probably also begin work upon the Jasper quadrangle, Alabama.

Arkansas.—Professor A. H. Purdue will make an areal and economic survey of the Winslow quadrangle, Arkansas. If time permits, he will also make an economic investigation of the developed slate deposits of Arkansas.

California.—The areal geology of the Redding quadrangle, California, will be revised by Mr. J. S. Diller. He will also complete an areal and economic survey of the Indian Valley Special quadrangle, California.

Mr. Arthur C. Spencer will cooperate with Mr. Waldemar Lindgren in making an investigation of the economic geology of the Redding quadrangle, California.

An areal and economic survey of the Tejon quadrangle, in southern California, will be made by Mr. George H. Eldridge. He will also make, for correlation purposes, the necessary reconnaissance examinations of regions adjacent to this quadrangle.

The areal and economic survey of the Santa Cruz quadrangle, California, will be completed by Dr. J. F. Newsom, who will be assisted by Dr. Ralph Arnold.

Dr. G. K. Gilbert will continue his investigations of the glaciology and physiography of the High Sierras.

Colorado.—Under the direction of Dr. Whitman Cross, detailed areal mapping will be continued in the San Juan region of Colorado.

The Ouray quadrangle will be surveyed and the work extended as far as possible into the adjoining Lake City quadrangle. The survey of the Engineer Mountain quadrangle will also be completed. Dr. Cross will have the assistance of Messrs. Ernest Howe, W. H. Emmons and Albert Johannsen.

Mr. J. E. Spurr will begin an investigation of the areal and economic geology of certain mining districts in Colorado, chiefly in Gilpin and Clear Creek counties. Mr. Spurr will be assisted by Messrs. Sydney H. Ball, George H. Garrey and Oscar H. Hershey.

Mr. S. F. Emmons will complete his monograph on the geology of the Leadville mining district and Dr. J. D. Irving will make an investigation of the ore deposits of the Ouray district.

Delaware.—The Cretaceous and Tertiary formations of Delaware will be investigated by Professor William B. Clark.

Florida.—Mr. George H. Eldridge will complete field work in the phosphate district of Florida and prepare a final report on the region.

Georgia.—A thorough revision of the areal, structural and economic geology of the Cartersville special and Cartersville regular quadrangles, Georgia, will be made by Mr. Laurence LaForge. Preliminary work will be done in the Dahlonega district by Mr. Arthur Keith.

Idaho.—The areal and economic survey of the Cœur d'Alene mining district, Idaho, will be completed by Dr. F. L. Ransome. Special attention will be given to the ore deposits. Such reconnaissance examinations of the adjoining regions as may be deemed necessary will be made. Mr. F. C. Calkins will assist Dr. Ransome in this work.

Indian Territory.—Areal and economic surveys of the Sansbois, McAlester, Tuskahoma and Windingstair quadrangles, Indian Territory, will be made by Mr. J. A. Taff. Mr. E. O. Ulrich will cooperate with him in determining the stratigraphic succession in Indian Territory.

Kansas.—Mr. F. C. Schrader will make an areal and economic survey of the Independence quadrangle, Kansas. He will be assisted by Professor Erasmus Haworth, who will pay special attention to the investigation of the underground structure and its relation to the accumulation of oil and gas.

Louisiana and Texas.—Professor N. M. Fenneman will make an economic investigation of the oil fields of the gulf coastal plain of Texas and Louisiana.

Maine.—Dr. George Otis Smith will, with the assistance of Messrs. E. S. Bastin and C. W. Brown, continue the survey of the Penobscot Bay quadrangle in Maine. Dr. Smith will also exercise general supervision over geologic work in New England and the crystalline belt of New York and New Jersey.

Maryland.—Acting in cooperation with the Maryland State Geological Survey, Professor William B. Clark will continue areal and economic surveys in Maryland for the preparation of geologic folios.

Massachusetts.—Professor B. K. Emerson will continue his investigation of the areal and structural geology of central Massachusetts.

Mississippi.—In cooperation with the division of hydrology, Mr. E. C. Eckel, assisted by Mr. A. F. Crider, will prepare a report on the geology and the water resources of Mississippi.

Missouri.—The Silurian and Ordovician paleontology of central Missouri will be investigated by Mr. E. O. Ulrich, who will work in cooperation with the state survey. The lead and zinc deposits of the state will be examined by Dr. H. F. Bain.

Montana.—Mr. W. H. Weed will complete the preparation of a report on the Butte mining district.

New Jersey.—In cooperation with Messrs. N. H. Darton and W. B. Clark, Dr. Florence Bascom will make an areal survey of the pre-Paleozoic formations of the Trenton quadrangle, New Jersey, in preparation for the Trenton folio. Dr. Bascom will also complete the mapping of the Paleozoic, pre-Paleozoic and Pleistocene formations in the Burlington, Lambertsville, Bordentown and Princeton quadrangles.

Professor W. S. Bayley will complete the mapping of the crystalline rocks of the Raritan quadrangle, New Jersey. He will also

make an areal, economic and structural survey of the crystalline rocks of the Delaware Water Gap, Easton and Allentown quadrangles, in New Jersey and Pennsylvania.

A thorough field revision of the areal and economic geology of the Franklin Furnace quadrangle, New Jersey, will be made by Dr. A. C. Spencer, who will also prepare a report on the economic geology of the district. Dr. Spencer will cooperate with Professor J. E. Wolff in the preparation of the Franklin Furnace folio.

New York.—Professor R. S. Tarr will complete his investigation of the Pleistocene geology of the Watkins Glen quadrangle, New York, and will prepare the Pleistocene section for the Watkins Glen folio. He will also investigate the Pleistocene geology of the Harford-Owego quadrangle, New York, and prepare the Harford-Owego folio in cooperation with Professor H. S. Williams.

Professor Williams, assisted by Dr. E. M. Kindle, will make an areal and economic survey of the quadrangle that embraces the Dryden, Harford, Owego and Appalachian quadrangles, New York.

Professor J. F. Kemp will continue the areal and economic survey of the eastern part of the Adirondack region.

Nevada.—Mr. J. E. Spurr will visit the Tonopah district, Nevada, some time during the summer, in order to make a final revision of his conclusions before publishing the report on the Tonopah ore deposits on which he has been at work for the last year.

North Carolina, South Carolina, Tennessee and Georgia.—Mr. Arthur Keith will complete areal and economic surveys of the Mount Mitchell, Nantahala, Cowee, Pisgah, Roan Mountain and Morganton quadrangles, in North Carolina, South Carolina and Tennessee, with a view to the preparation of geologic folios. Assisted by Mr. Hoyt S. Gale, he will make a reconnaissance of the Hickory, Pickens, Walhalla and Dahlonega quadrangles, North Carolina and Georgia. Dr. W. Lindgren, assisted by Mr. L. C. Graton, will make a preliminary investigation of the mineral resources, particularly gold and tin, in several counties of the northeastern part of South Carolina.

Ohio and West Virginia.—A revision of the Cadiz-Steubenville quadrangles in Ohio and West Virginia will be made by Mr. M. R. Campbell, who will prepare the Cadiz-Steubenville folio in cooperation with Mr. W. T. Griswold.

Pennsylvania.—Mr. M. R. Campbell will revise the mapping of the Slatington quadrangle, Pennsylvania, for the preparation of the Slatington folio. In cooperation with the state of Pennsylvania, he will also survey for folio publication the Amity, Rogersville, Burgettstown and Claysville quadrangles. In this work he will have the assistance of Messrs. W. T. Griswold and F. C. Clapp.

The Trenton limestones of eastern Pennsylvania and their continuation into New Jersey will be mapped by Mr. R. S. Bassler for the purpose of furnishing information to Mr. E. C. Eckel that may be of assistance to him in the preparation of his report on the cement resources of the United States.

In cooperation with Messrs. N. H. Darton and W. B. Clark, Dr. Florence Bascom will complete the field work and prepare for publication the Philadelphia special folio.

Texas.—Mr. E. C. Eckel will visit northeastern Texas, particularly Marion, Cass, Morris, Camp, Harrison and Upshur counties, for the purpose of making a reconnaissance examination of iron-ore deposits and determining the areas in which topographic and geologic work can most advantageously be taken up next year.

Utah.—Mr. J. M. Boutwell will complete an investigation of the mining geology of the Park City district, Utah. He will also make a reconnaissance of the areal, stratigraphic and structural geology of the western portion of the Uinta Mountains. Mr. Lester H. Woolsey will assist him.

Vermont.—Areal and economic surveys will be made in western Vermont by Professor T. Nelson Dale.

West Virginia.—Dr. George H. Ashley, assisted by Mr. W. C. Phalen, will make areal and economic surveys of the Nicolas quadrangle, West Virginia.

Mr. George W. Stose will complete the areal and economic surveys on the Pawpaw and Hancock quadrangles, in West Virginia and Maryland. He will be assisted by Mr. E. F. Burchard.

Wisconsin.—Professor U. S. Grant will make an areal and economic survey of the Mineral Point quadrangle, Wisconsin. The work will probably be done in cooperation with the state survey of Wisconsin.

BARON TOLL.

PRINCE KROPOTKIN contributes to the last number of the *Geographical Journal* an account of the return of the expedition sent to search for Baron Toll, under the direction of Lieutenant Kolchak. There appears to be little hope that Baron Toll and Dr. Seeberg have survived. The last news from them is a letter found in Bennett Island and dated November 8, 1902. It is as follows:

In company with the astronomer, F. G. Seeberg, and two hunters, the Tungus Nicholas Diakonoff and the Yakut Vassili Gorokhoff, on June 7, I left the winter harbor of the *Zarya* (Nerpichiya Bay of Kotelnyi Island). We followed the northern coasts of Kotelyni and Thadéeff Islands, keeping our course towards Cape Visoki on New Siberia. On June 13 I took the course towards Bennett Island. The ice was pretty broken. On June 25, three miles from Cape Visoki, the ice was definitely broken. Preparing to take to our *baidaras* [leather boats], we killed our last dogs. From here we were carried on an ice-floe, for four and a half days, 48 miles in the desired direction. Then, having noticed that our ice-floe had drifted 10 miles southwards, we left it on July 31, and after having covered the remaining 23 miles in our *baidaras,* landed on August 3 on Bennett Island, at Cape Emma.

According to the survey of Seeberg, who has also determined the magnetical elements both here and on the journey—in ten places in all—Bennett island is a plateau, not higher than 1,500 feet. By its geological structure it appears as a continuation of the plateau of Middle Siberia, which is built up, here also, of very ancient marine deposits (Cambrian), pierced by irruptions of basalt. In places one finds, under the sheets of basalt, deposits of brown coal with relics of vegetation, namely conifers. In the valleys of the island, bones of mammoths and other Quaternary-period animals, washed out of the deposits, are found occasionally.

As to the present inhabitants of Bennett Island, they are, besides the temporary visitor, the walrus, the polar bear and the reindeer. A herd of some thirty of the latter wandered on the rocky feeding-ground of the island. We fed upon them, and made out of their skins the fur cloth and the boots required for the winter journey. The following birds stay here: two species of *Somateria,* one sandsnipe, one bullfinch and five species of gulls, including the roseate one.

As for migratory birds, we saw one eagle which flew south to north, one falcon which flew north to south, and geese whose flock went also north to south. Owing to fogs, we could not see the land wherefrom these birds came; neither could we see Sannikoff's Land, any more than during our last navigation.

We are going to leave here the following instruments: a reflecting circle with artificial horizon, a Krause's inclinator, the anemometer, the photographic apparatus 'Norah,' and some others.

To-day we are going southwards. We have provisions for fourteen to twenty days. All in good health. 76° 38′ N. lat., 149° 42′ E. long.

SCIENTIFIC NOTES AND NEWS.

LORD KELVIN celebrated his eightieth birthday on June 26.

MR. W. H. M. CHRISTIE, the astronomer royal, and Sir David Gill, of the Cape Observatory, have been elected corresponding members of the Paris Bureau des Longitudes.

THE University of Manchester has conferred the doctorate of science on Professor Bohuslav Brauner, Ph.D., of the Czech University of Prague, Mr. Ludwig Mond, F.R.S., and Mr. W. H. Perkin. Professor Dixon, in making the presentations, said Dr. Brauner was an old student of this university, and one of

Mendeléef's most distinguished disciples. Dr. Mond had almost realized the dream of the alchemist of transmuting common things into gold. Dr. Perkin had extracted from coal tar a whole spectrum of colors, and was, since Faraday's time, the man who had followed most deeply the vibrations of light as they penetrate molecules.

M. A. Chauveau, professor at the Paris Museum of Natural History, has been elected director of the Marey Institute for Physiology in the room of the late M. Marey.

The Scottish Geographical Society has awarded its Livingstone gold medal to Commander Robert Scott, leader of the British Antarctic Expedition, and the society's gold medal to Mr. W. S. Bruce, leader of the Scottish Antarctic Expedition.

Professor Ernest F. Nichols, of the department of physics in Columbia University, has sailed for Europe and will spend next year in work at Cambridge, Berlin and Paris.

Miss W. J. Robinson, instructor in biology in Vassar College, and Miss M. M. Brackett have gone to the Cinchona Laboratory of the New York Botanical Garden to carry out some embryological investigations. Mr. G. W. Collins, of the U. S. Department of Agriculture, Mr. Wm. R. Maxon, of the U. S. National Museum, and Mr. Louis Agassiz Fuertes, of Ithaca, New York, have also recently carried out certain studies at Cinchona.

Professor Clara E. Cummings, of Wellesley College, has been granted a sabbatical year, which will be spent in resting and studying the tropical flora. Associate Professor Furguson will have charge of the department for the year.

Professor James Geikie has been elected president of the Scottish Geographical Society in succession to Sir John Murray.

An Association for the Relief, Control and Prevention of Tuberculosis has been established at Newport, R. I., with Mr. Robert Frame as president.

Dr. W. Schottler, of Maintz, has been appointed geologist in the Geological Institute at Darmstadt.

Lord Avebury was reelected president of the Ray Society at the annual meeting on June 9. The other officers are: *Vice-Presidents,* Dr. R. Braithwaite, Mr. A. D. Michael and Lord Walsingham, F.R.S.; *Treasurer,* Dr. DuCane Godman, F.R.S.; and *Secretary,* Mr. John Hopkinson.

Mr. Francis Edward Macmahon, inventor of the telegraph tape machine known as the 'ticker,' died in England on July 5. He served in the United States navy during the civil war, and was in Admiral Farragut's flagship at the taking of New Orleans. Subsequently he settled in England, and of late years patented many inventions, ranging from a tap to a chainless bicycle.

The United States Civil Service Commission announces an examination on July 27, 1904, to secure eligibles from which to make certification to fill a vacancy in the position of mechanician in the Bureau of Standards, at $900 per annum, and other similar vacancies as they may occur in that bureau. No educational test will be given, and it will not be necessary for applicants to appear at any place for examination. The appointee must have had five years' shop experience, two of which must have been spent in a shop in which scientific instruments were constructed.

Professor M. Ascoli, president of the Associazione Elettrotecnica Italiana, writes to the *Electrical World* that no fewer than 41 members have already formally engaged themselves for the trip to America, arriving in two parties about August 24–25. The official representatives will be Professor Ascoli and the two vice-presidents, Professor G. Brasi, of Turin, and Professor L. Lombardi, of Naples. The delegates of the Italian Government to the Electrical Congress will be Professor Ascoli on behalf of the Ministry of Posts and Telegraphs, and Professor Lombardi, for the Ministry of Public Instruction.

The Journal of the American Medical Association states that the date set for the next session of the American Medical Association is July 11–14, 1905. This date has been decided on after considerable correspondence. The holiday season for the majority of medical

men is from about the first week in July to September, and the schools have by that time all closed. Most of those who live in the east will want to utilize the trip to the association meeting as their summer vacation, and if the date were that usually adopted for the association meeting, these would not be able to attend. In July Portland has a delightful climate, and consequently there need be no fear of hot weather.

WE also learn from the *Journal of the American Medical Association* that the American Society of Tropical Medicine has been incorporated in Philadelphia. The officers are: *President,* Dr. Thomas H. Fenton, Philadelphia; *vice-presidents,* Dr. James Anders, Philadelphia, and Dr. I. G. Kinyon, Glenolden, Pa.; *secretary,* Dr. Joseph McFarland, Philadelphia; *assistant secretary,* Dr. John M. Swan, Philadelphia; *treasurer,* Dr. Wharton Sinkler; council: Drs. R. G. Curtin, Judson Daland, Allen J. Smith, and W. M. L. Coplin. The men elected to honorary membership for valuable research work in the prevention of tropical diseases are: Surgeon-General William H. Forwood; Rear-Admiral Surgeon P. M. Rixey, Dr. Walter Wyman, Sir Patrick Manson of England, Dr. A. Laveran of the Pasteur Institute, France; Professor Robert Koch, Germany; Professor Charles J. Martin, Sydney, N. S. W.; Professor Aristides Agramonte, University of Havana, Cuba; Dr. Frederick Montazambert, chief health officer of the Dominion of Canada; Professor Kitasato, University of Tokio, and Professor Eduardo Liceaga, head of the department of health, Mexico.

THE Board of Estimate of New York City has appropriated $10,000 to pay the expenses of a commission of medical experts to pass on the question whether or not pneumonia is a contagious disease.

THE Emperor Francis Joseph laid on June 21 the foundation stone of the new General and University Hospital for Vienna, to replace the old general hospital built 120 years ago.

IT is announced that if sufficient support can be secured it is intended to publish from the office of *The Journal of Medical Research,* Boston, an atlas of bacterial infections in man. It will consist of one hundred plates—a few in color—with descriptive text. The reproductions will be ten by twelve inches, a large number of them with but one figure on a plate, printed on heavy paper and in the best manner. The volume will be furnished bound in half morocco, and copies will be numbered, for the edition will be limited. The price will be ten dollars delivered free in the United States and Canada. The authors will be Dr. H. C. Ernst, professor of bacteriology in the Harvard Medical School, and Dr. S. B. Wolbach, first assistant resident pathologist to the Boston City Hospital.

MR. W. W. CANADA, consul at Vera Cruz, Mexico, writes that an agitation has been on foot for some time looking to the passage of a law to prevent the wanton destruction of birds throughout Mexico; in fact, a proposed law has already been presented to the government by the Association for the Protection of Birds, and it is confidently expected that it will meet the approval of the executive. This law is intended to prevent the killing of certain classes of birds useful to the agriculturist. Other kinds, such as for instance game birds, may be killed only at stated periods of the year. All birds of prey, and others destructive to the interests of the farmer, may be killed at any time and by anybody. Such a law, if rigidly enforced, can not fail to be of great benefit to the people of the United States, as for instance in the case of migratory birds that winter in Mexico, or even farther south, and that return to the north in the proper season if not killed off in the meantime.

A WILD Birds Protection Acts Amendment (St. Kilda) Bill has been introduced in the British parliament by Sir Herbert Maxwell. To it is prefixed the following explanatory memorandum: "By section 9 of the Wild Birds Protection Act, 1880, it was provided that the operation of that act should not extend to the island of St. Kilda. The object of this bill is by extending the protection afforded by that act to St. Kilda to provide means for saving the St. Kilda wren and other

birds, which are becoming rare from the extermination with which they are threatened. It is proposed to exempt certain birds from the schedule to the act of 1880 as being required for the support of the inhabitants of the island." Protection is given by the bill to the fork-tailed petrel, in addition to the St. Kilda wren, and the birds to be exempted from the schedule of the act of 1880, so far as regards the island of St. Kilda, are the fulmar, gannet, guillemot, puffin and razorbill.

In the Hawaiian Islands it is now recognized that forest preservation is a matter of great and immediate importance to the leading economic interests of the territory. The chief agricultural interest of the islands is sugar growing. In 1903 the exported sugar was valued at $25,310,684, or 96 per cent. of the total exports. The supply of water on which successful cane cultivation depends comes to a large extent from the forested higher slopes of the mountains, above the plantations. But the situation is complicated by the fact that cattle raising, which in economic importance stands second only to the sugar industry, depends largely on the use of the forest for range, and overgrazing has been the principal cause of injury to the water-holding power of the wooded area. As a preliminary to the formulation of a policy in the interest of the islands as a whole, the territory a year ago asked for an examination of the whole question on the ground by an agent of the United States Department of Agriculture. The report of Mr. William L. Hall, of the Bureau of Forestry, who made the examination, is now being printed as Bulletin No. 48, 'The Forests of Hawaii.' Both from a scientific and practical standpoint it gives much information concerning these Hawaiian forests and their uses. The conflict of interests between the cattlemen and the sugar planters is evident, but need not seriously menace rehabilitation of the forests. The cattle-men in many instances desire the forests for pasturage. The planters rightly contend for the intact forest with perfect floor cover to secure the greatest possible storage of water for the supply of growing crops. But the clashing of interests is happily reduced by other conditions, chief of which is that sugar growing is the great sustaining industry and the dominant source of income. An additional potent fact is that many cattle raisers are also sugar growers, and their double interests compel them to take the broadest view of the needs of the islands as a whole. The Bureau of Forestry has supplied the islands with a forester, and is actively cooperating with the territorial authorities in all matters of policy.

The Interstate Commerce Commission reports that the total number of casualties to persons on the railways of the United States for the year ending June 30, 1903, was 86,393, of which 9,840 represented the number of persons killed and 76,553 the numbered injured. Casualties occurred among three general classes of railway employees, as follows: Trainmen, 2,070 killed and 25,676 injured, switch tenders, crossing tenders, and watchmen, 283 killed, 2,352 injured; other employees, 1,253 killed, 32,453 injured. The casualties to employees coupling and uncoupling cars were, employees killed, 281; injured, 3,551. For the year 1902 the corresponding figures were, killed, 167; injured, 2,864. The casualties connected with coupling and uncoupling cars are assigned as follows: Trainmen killed, 211; injured, 3,023; switch tenders, crossing tenders and watchmen killed, 57; injured, 416; other employees killed, 13; injured, 112. The casualties due to falling from trains, locomotives or cars in motion were: Trainmen killed, 440; injured, 4,191; switch tenders, crossing tenders and watchmen killed, 39; injured, 461; other employees killed, 72; injured, 536. The casualties due to jumping on or off trains, locomotives or cars in motion were: Trainmen killed, 101; injured, 3,133; switch tenders, crossing tenders and watchmen killed, 15; injured, 279; other employees killed, 82; injured, 508. The casualties to the same three classes of employees in consequence of collisions and derailments were: Trainmen killed, 648; injured, 4,526, switch tenders, crossing tenders and watchmen killed, 17; injured, 137; other employees killed, 128; injured, 743. The number of passengers killed in the course of the

years 1903 was 355, and the number injured 8,231. In the previous year 345 passengers were killed and 6,683 injured. There were 173 passengers killed and 4,584 injured because of collisions and derailments. The total number of persons, other than employees and passengers, killed was 5,879; injured, 7,841. These figures include the casualties to persons classed as trespassing, of whom 5,000 were killed and 5,079 were injured. The total number of casualties to persons other than employees from being struck by trains, locomotives or cars, were 4,534 killed and 4,029 injured. The casualties of this class were as follows: At highway crossings, passengers killed, 3; injured, 7; other persons killed, 895; injured, 1,474; at stations, passengers killed, 24; injured, 108; other persons killed, 390; injured, 501; at other points along track, passengers killed, 8; injured, 14; other persons killed, 3,214; injured, 1,925. The ratios of casualties indicate that 1 employee in every 364 was killed, and 1 employee in every 22 was injured. With regard to trainmen—that is, enginemen, firemen, conductors and other trainmen—it appears that 1 trainman was killed for every 123 employed, and 1 was injured for every 10 employed. One passenger was killed for every 1,957,441 carried, and 1 injured for every 84,424 carried. With respect to the number of miles traveled, however, the figures show that 58,917,645 passenger-miles were accomplished for each passenger killed, and 2,541,096 passenger-miles for each passenger injured.

THE council and officers of the Institution of Civil Engineers gave a dinner on June 19 at the Grand Hotel to the president, Sir William H. White. Among those present were Sir Guilford L. Molesworth (in the chair), Lord Kelvin, Sir Benjamin Baker, Professor Sir James Dewar and Sir William H. Preece.

THE Paris papers of June 22 publish accounts of the 'le fête du soleil'—a sort of modern sun-worship function held in the Eiffel tower in Paris on the night of June 21. *Le Matin* of June 22 says that M. Janssen was the high priest of the occasion, and that an address 'd'une effrayante erudition' was delivered by M. Flammarion. At half past twelve the assemblage mounted to the summit of the tower to 'assist' at the rising of the sun. The paper remarks that "the ceremony was a calm and dignified one which the moon lit up without jealousy. For though it be stoutly and most learnedly affirmed that there was no night, it is none the less true that if one could see clearly it was on account of the moon, not to mention electricity."

IT is stated in *Nature* that the twenty-second congress of the Sanitary Institute will be held in Glasgow from July 25–30, under the presidency of Lord Blythswood. Sir Richard Douglas Powell, Bart., K.C.V.O., will deliver the lecture to the congress on 'The Prevention of Consumption.' It appears from the program that 250 authorities, including several county councils and county boroughs, have already appointed delegates to the congress, and as there are more than 3,300 members and associates in the institute, there will probably be a large attendance in addition to the local members. In connection with the congress, a health exhibition of apparatus and appliances relating to health and domestic use will be held as practical illustration of the application and carrying out of the principles and methods discussed at the meetings. Popular lectures will be given in the exhibition on physical development, by Dr. P. Boobbyer; care of eyesight, by Dr. James Kerr; care of the teeth, by Mr. G. Cunningham; feeding and digestion, by Professor A. Bostock Hill; and healthy houses, by Professor H. R. Kenwood. The sections and their presidents are: (1) Sanitary science and preventive medicine, Professor J. Glaister; (2) engineering and architecture, Professor H. Robinson; (3) physics, chemistry and biology, Professor Frank Slowes. There will be eight special conferences, the subjects and presidents of which will be as follows: Municipal representatives, Mr. W. F. Anderson; industrial hygiene, Mr. J. Steele; medical officers of health, Sir C. A. Cameron, C.B.; engineers and surveyors to county and other sanitary authorities, Mr. W. Weaver; veterin-

ary inspectors, Professor James McCall; sanitary inspectors, Mr. T. F. Strutt; women on hygiene, the Duchess of Montrose; the hygiene of school life, Professor John Edgar.

UNIVERSITY AND EDUCATIONAL NEWS.

We learn from the London *Times* that the Schunck Laboratory, bequeathed to Owens College by the late Dr. Schunck, who had in his lifetime endowed the college with £20,000 on behalf of chemical research, has been removed from his residence at Kersal and rebuilt in the college precincts as nearly as possible in its original form. It comprises two floors and a basement, with the most modern appliances, also a valuable library and a collection of coloring matter, natural and artificial. Dr. Perkin, who assisted Dr. Schunck in the development of alizarin, performed the ceremony of opening the laboratory in its new home on July 1. Mrs. Schunck presented, through her son Mr. Charles Schunck, a medallion portrait of her late husband, which has been placed in the laboratory.

Members of the graduating class of Harvard University expect to pursue work as follows:

Business	128
Law	121
Teaching	68
Scientific pursuits	68
Medicine	20
Railroading	14
Architects	12
Ministry	8
Journalism	7

The fact that ten times as many students expect to follow scientific pursuits as will enter the ministry witnesses a great change that has taken place within recent years.

The relation that the evolutionary theory as originally laid down by Darwin has come to have in what would once have been regarded as widely removed fields was specially considered by the zoological department of the University of Michigan the second half of this college year. The course was supplementary to the course on organic evolution, and aimed to give a critical appreciation of the development of the evolution theory since Darwin, and of the bearing of that development on various fields of knowledge. The theory of evolution has so profoundly influenced psychology, ethics and social science, to say nothing of other subjects, that an acquaintance with the ground and import of this theory is a necessary part of the equipment of the student in any of these fields, as well as of the biologist, who has an interest in the broader aspects of his work. It was the purpose of the course to give the student the necessary basis for appreciating in some degree the import of biology. Somewhat more than half the time was devoted to organic evolution, particularly to its post-Darwinian developments, while the remainder was devoted to the evolution of the behavior of the lower animals and of man, and to social and ethical evolution. The course was conducted by different members of the zoological staff, each dealing with those aspects of the subject to which he has devoted especial attention.

At the June meeting of the trustees of Western Reserve University the following appointments were made in the Medical Department: Torald Sollman, professor of pharmacology and materia medica; Frederick Clayton Waite, associate professor of histology and embryology; Roger G. Perkins, assistant professor of bacteriology and pathology; Percy W. Cobb, demonstrator in physiology; E. D. Brown, demonstrator in pharmacology and materia medica; J. B. Austin, demonstrator in histology and embryology. The following gifts were received during the year: For the endowment of Harry Willson Payne Professorship, $100,000; for the Adolph Cudell Library fund, $200; for current budget expenses, $5,000.

Professor Howard J. Banker, of the Southwestern Normal College of Pennsylvania has been elected professor of biology in DePauw University at Greencastle, Indiana.

Professor Georg Gaffky, professor in the University of Giessen, has accepted a call to occupy the chair vacant through the resignation of Dr. Robert Koch, in the University of Berlin.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 29, 1904.

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THE MOSELY EDUCATIONAL COMMISSION.[*]

I.

THE places visited by me as a member of the commission were New York, Baltimore, Washington, Cleveland (Ohio), Buffalo, Ithaca (Cornell University), Boston, Yale and Middletown (Conn.). But on a previous occasion, six years ago, when I was three months in the country, I crossed the American continent twice from east to west, including the journey from Montreal to Vancouver by the Canadian Pacific Railway. I then spent a considerable time in the west and saw much of Chicago, as well as of Minneapolis and the great wheat region in the northwest. As a student, I was brought much into contact with Americans; this has led me always to take a special interest in them, and I have all my life been a close observer of American scientific work. Any opinions that I may have formed are, therefore, something more than mere impressions derived from my recent brief visit.

It is very difficult to evaluate the part which school education plays in the United States of America. That it plays a real part can not be doubted; but there is clearly a tendency somewhat, if not greatly, to exaggerate its relative importance as a factor in the national welfare. In point of fact, American cuteness would seem to be conditioned by environment rather than by school education. The country was settled by adventurous, high-minded men; the adventurous and restless spirits of Europe have been attracted there for generations

[*] Report of Professor Henry E. Armstrong, Ph.D., LL.D., F.R.S.

past; the conditions have always been such as to develop enterprise and to stimulate individuality and inventiveness: so that, during the whole period in which the continent has been gradually acquired and settled on, there has been a constant invigorating struggle going on against nature in one form or another, the Indian probably having played no mean part in the education of the race. ' Such being the case, it is important to remember that some at least of these influences are now withdrawn and that development may, in consequence, be along different lines in future, especially as the enervating influence of machinery is also coming into play more and more.

In some respects, the Americans may be said to be a distinct if not an improved breed. Certain proclivities have undoubtedly been unconsciously selected out, and there has been much cross breeding; hence a race has been developed differing in important respects in its type of thought, if in no other way, from those represented in Europe. Moreover, success has given them belief in themselves and leads them to trust themselves. The natural resources at their disposal are boundless and their outlook is extraordinarily hopeful; they are born optimists, in fact. They have also learnt to work together and to accept and support party rule; they seem, indeed, to tolerate direction and to subordinate their individual opinions to an extent which we have difficulty in believing possible—so much so that they may be said to lack individuality. Willingness to organize and to be organized is almost characteristic of the nation. Uninfluenced by tradition, they are eminently receptive—always ready to consider and test new ideas; nevertheless, the conservatism characteristic of a young country is in many ways still manifest among them.

It is difficult to trace the development of any American peculiarities to the schools —or to find any evidence even that the schools seek to utilize and develop the national idiosyncrasies.

After seeing a number of schools in detail—both common schools and public high schools—it seems to me that they are much as our schools; that the problems they are seeking to solve are our problems; that their difficulties are our difficulties. In matters of organization and administration, we apparently can learn many things from them; but, as regards method, it seems to me that we have very little to learn; indeed, in depth of purpose and originality, our best work may not unfairly be said to be considerably in advance of theirs. But whereas here we have no general belief in education, in America the common school system is universally held in high esteem and its influence is very great. The mere fact that all classes are brought together in the common school is in itself of the utmost importance as affecting the social outlook; even those who prefer to send their children to private high schools seem to think it desirable that they should first attend the common school in order that they may consort with others.

The belief in secondary education, especially for boys, is far less general—it is probably no greater than ours—and yet, it seems to me, that it is by the existence of a well-developed public high school system that America is distinguished most from us and potentially placed most in advance of us.

What has until recently counted as university education here is almost unknown in America. What will count as university education here ere long, as the various provincial universities become effective, is already developed in America to a considerable extent and is advancing with giant strides. The support of university education is become a fashionable practise among

multi-millionaires, and the appreciation of such education by employers generally has reached a point as yet undreamt of here and is growing rapidly, owing to the establishment of an effective working connection between the manufacturing industries and the colleges. The belief in higher education may be expected to grow at a compound interest rate. This, it seems to me, is the great fact to be taken note of, if—as we undoubtedly must—we are to regard education as an effective means of promoting national welfare. It will undoubtedly force on the development of the public high schools. But, as I shall have occasion to point out, American education is for the most part still governed by eminently academic and conservative traditions; in some respects it lacks depth and practical outlook to a strange extent.

The movement which has led here, during the past twenty years, to the erection of technical schools all over the country and of the numerous polytechnics in London, is only beginning to come into evidence in America. Evening class instruction, such as has grown up under our science and art department, is almost unknown there.

In New York and other large towns we saw many fine public school buildings. But if buildings are to be regarded as evidence of appreciation, we may point to those erected by school boards all over this country; it is probable that in size, number and appointments they compare not unfavorably with those to be found in America, taking into account the areas dealt with. The building, it must not be forgotten, appeals to the public sense: it can be pointed to with pride. This is distinctly the attitude adopted in America towards the public school buildings. I am not aware that we take particular pride in the erection of our board schools: it is rather our habit to grumble at the outlay they involve.

The Common Schools.—In interior arrangements even the most modern schools are not superior to our own. And there is even less attempt made in them to provide pictorial decoration. Thring's great doctrine of *thinking in shape* has, if possible, made less advance thus far in the American common schools than in ours.

Much has been said of the importance attached in the American schools to the teaching of patriotism and to the practise of saluting the flag which prevails in them. This involves the recitation occasionally of the formula: 'I pledge allegiance to my flag and to the republic for which it stands —one nation, indivisible, with liberty and justice for all.' This appeared to me to be a somewhat perfunctory exercise when I witnessed it. Thinking Americans with whom I discussed the question seemed to regard the practise as of some value in cities like New York and Chicago, where a large alien element has constantly to be absorbed into the population; but apparently they were of opinion that it was undesirable as a general practise.

It is almost unnecessary to say that the amount of attention paid in the common schools to reading and composition is in no way sufficient or satisfactory, the neglect of English among English-speaking people being proverbial. Apparently no greater effort is made in the American schools than in ours to lead children to read and to become really fond of reading.

The teaching of drawing is also undeveloped. Simple measurement work in association with drawing, which is being so much advocated here and which is gradually assuming importance in our schools, seems to be almost, if not quite, unknown. I did not learn that the attempt was being made anywhere to put the teaching of

arithmetic on a practical common-sense basis.

Although manual training figures in the program, the interpretation put upon the term seems to be very different from that which is usual here, drawing commonly counting as manual training. In some of the schools, where space permits, woodwork is introduced into the upper classes for boys, and cookery and needlework for girls. The belief in such work is evidently growing; but at present the schools are undoubtedly behind ours in promoting it and even more bookish than ours in their tendencies.

The nature study lessons I witnessed, when not specifically botanical or zoological and scientific in character, were eminently superficial and worthless.

As all classes attend the common schools, these can not be compared directly with our elementary schools, but must be thought of in connection both with these and with all other types of preparatory schools.

There are two striking features in them —the air of refinement due to the attention paid to dress, especially by the girls, the preponderating element in most classes; and the attitude of familiarity assumed by the class towards the teacher. Distinctions such as poverty or occupation might well condition even in a democracy are scarcely perceptible. In America the teacher does not seem to be regarded as the natural enemy of the boy—as a person to be circumvented. The method of teaching which appears to be generally adopted involves, as it were, the constant exchange of opinion between teacher and pupil—not, as is here the case, either the communication of information to the class by the teacher or the mere wringing of what is supposed to have been learnt from the pupil by the teacher. The method has both its advantages and its disadvantages. It develops that readiness of address which characterizes young Americans and leads children to give their opinions freely—far too freely many think—on all sorts of subjects; and it encourages cuteness. But it imposes a very heavy burden on the teacher and operates against close study and concentration of attention. In American schools there is no enforcement of discipline by means either of penalties or of prizes. Children are put on a footing with grown-up people and treated as young republicans.

How, then, is discipline maintained? Is it always? Perhaps the average American boy has not such a fund of animal spirits as the English boy—he is sprung from a tolerant race and from an early age tends to ape the behavior of his elders more than the English boy does. Certainly one great cause of good behavior is the presence of girls along with the boys. On the occasion of my former visit, I discussed with one of the chief inspectors in Washington the reasons why the system of mixed classes had been abandoned there and then resumed. I learnt that one of the possible reasons was that it had been found difficult to keep the boys in order when alone. But undoubtedly the chief hold teachers have on their classes is consequent on their maintaining the interest of the pupils. Many of my colleagues on the commission—not teachers—in fact, expressed the opinion on more than one occasion that the teaching was most interesting. But looking below the surface, I did not feel satisfied with all that I witnessed. Whilst every teacher will admit that it is necessary to create interest, we all know that it is not always possible to maintain this at bursting point and that in school, as in the world, uninteresting work must be done sometimes; that, in point of fact, it is most important to acquire the art of doing uninteresting work in a serious and determined way. The American system seems to me to be one which imposes a fearful strain upon the

teachers—especially as they are mostly women. And it has some serious consequences. One of these is inability to concentrate the attention. Everywhere the heads of the high schools complained that the pupils who came from the elementary schools could not concentrate their attention upon their work. Several were of opinion that under the somewhat more rigid conditions of the high school improvement in this respect gradually took place as the pupils moved up. On the other hand, in more than one case it was admitted candidly by the head teacher of the elementary school that the extent to which the children could concentrate their attention diminished as they grew older and passed up the school; thirty minutes, we were told, was the longest period during which boys could concentrate their attention and work effectively. This failing, I believe, is not unknown in our own schools.

Public High Schools.—Although we have no schools which are the precise equivalent of these, some of our higher grade elementary schools come very close to them in many respects. It is noteworthy that, in a city like New York, few who can afford to send their children to private schools make use of the public high school—one chief reason assigned being that the classes in the latter are so large that individual pupils can not receive sufficient attention. Of those who enter, in New York, about fifty per cent. (mostly boys) leave during the first year to go into business; under ten per cent. remain until the fourth year. It is said that a much larger proportion are retained in the schools in the middle west.

In common with all my colleagues, I was favorably impressed by the way in which English literature was taught, but I could not discover that the teaching was carried to a logical end and fondness for reading inculcated.* I found no more evidence that proper attention was paid to writing and English composition than in our schools; the subject which of all others is of primary importance seems to be equally neglected in both countries. I met with no proper attempt to correlate the English composition with any of the practical work.

In the teaching of mathematics and science, the American high schools seem to me to be considerably behind our best schools. I came across little evidence that the practical methods of teaching mathematics and geometry which are coming into vogue here are appreciated; and the old academic methods of teaching science seem to prevail almost exclusively. No proper foundation for such work is laid in the elementary schools.

In one respect there has been an important departure: the recognition of the value of manual training has led to the development of a special manual training department and, in some cases, of distinct manual training high schools; in the latter, manual training takes the place of classics. In some cases, perhaps the majority, these are tending to develop into trade schools and to aim at proficiency in wood and metal work; they are elaborately equipped with tools. Nominally, they profess to regard the manual work from an educational standpoint, but it is quite clear that in most cases the will passes for the deed and that the teachers are not competent to develop the subjects pedagogically.

But we met with one most remarkable

* In the new Morris High School in New York—a magnificent building to accommodate nearly 3,000 pupils—a very fine library will be provided. The head master told us that it was his intention to develop the use of this systematically and that many duplicates would be provided of important books. A feature in this school will be a permanently darkened class-room with electric lantern, etc., into which classes can go to witness lantern demonstrations in connection with geography lessons, etc.

exception in the Brooklyn Manual Training High School. The head master of this school, Mr. Larkin, has conceptions of the educational possibilities which manual training may afford which place him on a special plane. His school at present is very inadequately housed. New buildings, however, are to be provided, and it is to be hoped that these will not be so palatial and ornate as to destroy the true workshop-like character and atmosphere of the cramped quarters in which the work is now carried on. In the first year the boys do woodwork; in the second, metal work—chiefly forging; in the third, printing; in the fourth, machine-tool work. The second-year work was in the hands of a man of exceptional ability, not merely a smith, but an artist, so that the imagination as well as the mechanical aptitude of the boys was being well developed. The printing was in charge of a master who also taught chemistry in the school—an enthusiast who had mastered the art of printing and was teaching it *con amore*. Ocular demonstration of his persuasive powers was afforded by the presence in the workshop of a valuable linotype machine, which he had induced the makers to present to the school. We met with another man of this type teaching woodwork at a high school in Washington. He had been educated in the school and, perceiving the importance of the subject, had served for several years as a pattern-maker in the Navy Yard at Washington; then he had returned to the school as a teacher.

It is men such as these that are needed to put manual training on a proper footing—and it is all important that we should devise means of attracting such men into schools.

The introduction of printing as a school subject may appear altogether absurd, but Mr. Larkin gave us clear evidence in proof of its value. Not only, he argues, is it of importance as a manual, mechanical exercise, as the means of bringing lads into contact with a set of facts outside ordinary experience, as well as of familiarizing them with all that is involved in the production of the books they read, but it is also of value on the literary side. When lads are called upon to set up in type and print off something that they have written and to correct the proof, they begin to realize, in a way which is rarely done by the mere writer, how careless they have been in writing, how poor their style. We were favored with copies of a journal produced in the school—printed and illustrated there—which certainly gave evidence of great skill. Mr. Larkin has a true conception of the educational possibilities afforded by proper manual training: while depreciating the attempt to train up skilled workmen as tending to stereotype the teaching, he sees very properly that it affords opportunities both on the mechanical and artistic side for general culture and that it may be made a most important adjunct of the literary and scientific work. Had I enjoyed no other opportunity than that of meeting him and of learning his views, I feel that my visit would have been a fruitful one.

But elsewhere I found an almost absolute lack of imagination underlying the manual training work—vague ideas of possibilities but neither real understanding nor sufficient executive power—although technically much of it was excellent.

It may be hoped that manual training schools—both primary and secondary—will soon be established here in which at least half the time will be spent at experimental and manual work. There is no more important experiment to be made in education that that of determining the value of such schools. In these schools a whole floor at least should be fitted up as a workshop and every kind of manual work

should be carried on, so that there might be *unlimited manual temptation* in the path of the scholar, who should be free to attempt anything that he liked without following a routine course.

School Management.—It is generally known that the American school system is very ineffectively controlled at the present time and that it is too often dominated by political influences. This is well brought out in a recent article in the *Forum* for October to December, 1903. In New York, both the elementary and the high schools are controlled by an able city superintendent, who has a staff of inspectors under him, and all appointments are made on a civil service basis; but a year or two hence, I believe, a Tammany-appointed inspector may be his successor. All the schools work to programs authorized by the superintendent, one program being laid down for the elementary, another for the high schools. The latter, however, is based on the elective system, a considerable range in the choice of subjects being allowed. There is no doubt that this system is subject to considerable abuse and that 'soft options' are much in request. It is beyond question most desirable that special aptitudes should be developed and that teachers should be in every way mindful of these; but boys and girls can not always be judges of what is good for them, nor have they the necessary worldly knowledge to settle for themselves. The Americans do not seem to have settled any more than we have what are the necessary elements of a rational course of school study.

As they work to a common program, both the freedom of the high schools and the responsibility of their directors are limited in a way altogether unknown here, perhaps to an unfortunate extent. Given an ideal superintendent with an ideal staff, the system might work well. But no special effort is made or is likely to be made to secure such an ideal executive; yet it should be aimed at. The combined intelligence of the teachers must be in excess of that of the executive and it should be brought more into operation; unless the Americans desire to stereotype all teaching, they must be prepared to grant almost absolute freedom to their teachers. This does not preclude either the holding up of example or fair criticism. Both here and there the spirit of cooperation needs to be brought effectively into action. Our education department hitherto has had no intelligence department; it has had no clearly thought-out, definite educational policy; there has been no effective means of keeping the inspectorate informed on all matters relating to educational method and no recognized means whatever of securing exchange of opinion and discussion either among the inspectors themselves or between them and teachers at large. The work of education has been carried on in holes and corners into which outside influences have penetrated with difficulty. In both countries we need to organize the work on a scientific basis; there should be some conscious effort made to substitute the good for the bad and even for the mediocre.

Female Teachers.—Most of us who are conversant with school work were struck by the distinctly low average of attainment in the American high schools. To what is this attributable? In part probably to the conditions which prevail in American life; but in large measure also, I venture to think, to the prevalence of mixed schools and the preponderance of women teachers.

Admitting that it may be possible, even desirable, to bring up the two sexes together in the earlier years of school life, I venture to think that we must sooner or later come to admit that it is wrong to do so during the later years, if the object be to develop a virile man. To put the matter in very simple terms, it seemed to me on

the occasion of my former visit—and the impression was confirmed during my recent visit—that the boy in America is not being brought up to punch another boy's head or to stand having his own punched in a healthy and proper manner; that there is a strange and indefinable feminine air coming over the men; a tendency towards a common, if I may so call it, sexless tone of thought.

But if coeducation be bad in itself, it becomes infinitely worse when the teachers are mostly women; they should rather be men mostly. Nowhere is the claim on behalf of women to equality with men put forward so strongly as it is in the United States. Nowhere, I believe, would it be found to be more disproved in practise, if carefully inquired into. Women have sought in recent times to prove that they can compete successfully with men in every field; they claim to have succeeded, but the claim can not be allowed, I think. They have shown—what it was unnecessary to show—that they are indefatigable workers; and they have shown that they can pass examinations with brilliant success. But what has been the character of the examinations? Almost invariably they have been such as to require the reproduction of learning, not original effort. History records but very few cases of women with any approach to originality; it proves the sex to have been lacking in creative and imaginative power. Those who have taught women students are one and all in agreement that, although close workers and most faithful and accurate observers, yet, with the rarest exceptions, they are incapable of doing independent original work. And it must be so. Throughout the entire period of her existence woman has been man's slave; and if the theory of evolution be in any way correct there is no reason to suppose, I imagine, that she will recover from the mental disabilities which this has entailed upon her within any period which we, for practical purposes, can regard as reasonable. Education can do little to modify her nature. The argument is one which women probably will not, perhaps can not, appreciate. No better proof could be asked for, however, than is afforded by the consistent failure of women to discover special wants of their own—they have always merely asked to have what men have, to be allowed to compete with men. Domestic subjects have been taught in the most perfunctory manner possible.

Among the colleges we visited was that of Vassar—the chief college for women in the states. It accommodates some 900 students. The college is located amidst surroundings in full harmony with the grace of the inmates; their charm of manner overcame us completely, even in the brief period during which we were privileged to fraternize with them. The teachers are mostly men. The instruction is given entirely on academic lines; lectures are delivered on economics, but I could not discover that woman's work in the world—'domestics'—was considered in any specific way; it would come, I was told, under the head of technical education, which is eschewed. Apparently no use is made of the beautiful grounds in which the buildings are placed for nature-study or instruction in horticulture; as one of my companions remarked, nature is looked at only in the laboratory down a microscope tube.

In some of the western coeducational colleges, arrangements have been made to provide for woman's specific requirements, which have given great satisfaction, I am told; but this has been done at the instance of the men teachers.

The women teachers in America, it seems to me, are less likely than ours are to take a feminine point of view in instructing

girls. The general environment seems unfavorable to the development of domestic tastes.

From the point of view that I have ventured to advocate, women teachers must be, for most purposes, relatively inefficient; and as teaching is an occupation in which more than any other imaginative power, individuality, insight and originality are wanted, it is important that men rather than women should exercise the predominant influence. If it be the province of education to mold the race, there is no other question of greater importance claiming our attention at the present time—especially as the difficulty of obtaining male teachers is increasing day by day. In both countries it is imperative that we should discover means of attracting men with practical instincts and of superior mental gifts into the teaching profession.

The Training of Teachers.—The elementary schools, at least in the larger cities, enjoy an advantage over ours in that, I believe, their teachers usually all pass through a period of high school training prior to entering the normal or training school; their outlook is consequently, on the average, somewhat broader. The methods adopted in training teachers appear to be no less academic than ours.

The premier training establishment at the present time is the Columbia Teachers College, New York—a palatial establishment. The teaching given in this college is in part academic, in part professional, the predominant class of student being those who are training to become supervisors, *i. e.*, advisory or teaching inspectors.

I had hoped to find that in this college the academic training had a certain bias imparted to it, just as at our Cambridge a certain professional bias is given to much of the academic training of those who graduate in the engineering tripos. But I was disappointed. And I was also greatly disappointed by what I heard when attending some of the pedagogic classes; there was a high-flown air of unreality about the instruction; too much precept, too little practise; no really severe practise! The whole building seemed to me to be out of character with the work to be done; far too ornate; and the students—mostly women—looked far too respectable and tidy to please me. If they had been men I should have said that they needed to take their coats off and not to be above making their hands dirty. It does not seem likely that teachers so trained will be able to give the simple, practical, common-sense instruction that boys and girls stand so much in need of at the present day. The whole appeared to me to be a good illustration of the tendency that I seem to see in America to be guided by sentiment and emotion, and to work on academic rather than on practical lines. I do not think that the Americans can long claim to rank as a practical nation if such methods are allowed to prevail.

We have sinned and are sinning grievously here in the same way, but there are clear indications that we have recognized our mistake, and that we may shortly enter upon a new era in which common sense will prevail. I saw no such signs in America.

College and University Instruction.—Even if it were necessary it would be difficult to arrive at any consistent definition of the American college; but as a rule it may be said to aim at giving a liberal education rather than professional training. Where colleges or schools for both purposes exist, side by side, they together constitute the university. It is noteworthy that, with a few exceptions, the term university has only recently met with general application; Yale College, for example, obtained the

right to call itself Yale University only in 1887.

The college and university instruction, including that given in technical schools, is of interest to us at the present time from several points of view.

In the first place, in America, as here, great complaint is made that students come to college ill-prepared to do the work;* that games† occupy too large a share of attention; and that the bonds of discipline have been unduly slackened of late years.

* Professor J. J. Stevenson, of New York University, deals in a very outspoken manner with this question in the recent January number of *The Popular Science Monthly*. To quote a few sentences from his article: "The old adage says 'he who would command must first learn to obey.' That American lads are sorely in need of such training is only too evident. * * * Such training means—training to think, to reason. Lads too often fail to receive this training in secondary schools, as any instructor who has had to deal with freshmen can testify. Secondary schools to-day are little better than cramming houses to fit pupils to answer odds and ends of questions in papers for entrance examinations. Loose thinking and restlessness under restraint characterize the American students in the lower classes at college; lack of home training may be responsible in part for the latter characteristic, inferior teaching in secondary schools for the former."

† The report of the President of Harvard College for the year 1901–1902 contains for the first time the report of the chairman of the committee on the regulation of athletic sports. President Eliot's comments thereon are highly instructive: "This report is interesting from several points of view. It exhibits, in the first place, the large number of students who are actively engaged in the competitive sports taken together. The figures given are not accurate, but it is reasonable to suppose that at least two thousand students out of the thirty hundred in Cambridge take some active part in one or more of the thirteen sports in which an enumeration of the number of participants was made. * * * The chairman calls attention to the fact that the expenditures for football are steadily increasing. A quarter part of all who take part in this sport are injured enough to lay them up for ten days on the average, and a much larger proportion of those who really play the game are thus injured for the season. The changes in the rules during the past ten years have tended to increase the number of injuries rather than to diminish it. The temporary injuries are so numerous that it is impossible to count on putting any particular eleven men into an important game on a given day. In order to provide the necessary number of substitutes for each place, the football squad often numbers sixty men. Hence large expenditures. The outfit for candidates grows more expensive, because they wear about fourteen pounds weight of padding and armor. On the whole, the game, under the existing rules, tends to become slower and less visible in its details, and therefore less interesting. Moreover, the ethics of the game, which are the imperfect ethics of war, do not improve. The martial axiom—attack the enemy's weakest point—inevitably leads to a deliberate onslaught on the cripple or the convalescent in the opposing line; and the habitual violation of rules, if penalties be escaped, is regarded by many as merely amusing."

Moreover, it is said that those who have been brought up in towns are not such satisfactory students as those who have been brought up in the country. The latter are not only more earnest but more practical. On this account the spirit prevailing in some of the western colleges is said to be far better than that met with in many eastern colleges.

Although the elective system prevails very largely in those cases in which graduation from college is a necessary preliminary to professional study, the course is prescribed. It is very noteworthy that the course laid down is a broad one. Thus at the Johns Hopkins University, the following are the subjects prescribed in the chemical-biological or preliminary medical group:

	Hours Weekly.
First Year.	
Physics	9
Chemistry	9
Rhetoric	3
English Composition	4
Second Year.	
Chemistry	9
Biology	9
French	4
English Literature	3

Third Year.

Biology	9
Philosophy	5
History and Economics	4
Elective Course	2

English composition and reading, French and German, as well as economics, are included in all the complete engineering and science courses at the Case School of Applied Science, Cleveland, Ohio. The same practise is followed at the Massachusetts Institute of Technology, where, in addition, history (American and European) figures in the program. In these institutions the course lasts four years. The course of reading prescribed in the Case School is an instructive one.

I inquired specially into the teaching of English composition. At the Massachusetts Institute the instructor was taking the utmost pains to select themes likely to interest engineering students; but the possibility of directly correlating the laboratory work with the literary work had not been contemplated.

It appears to me that we may well take a leaf out of the American book and introduce an element of literary study into our engineering courses; but when the question is considered, I trust we shall endeavor to correlate the literary work very closely with the practical work. I did not discover that American students are any more willing to read studiously than ours are.

HENRY E. ARMSTRONG.

LONDON.

(To be continued.)

JOHN BELL HATCHER.

AMERICAN paleontology has suffered an irreparable loss in the untimely death of Mr. Hatcher, which took place, after a short illness, at Pittsburg on July 3.

John Bell Hatcher, the son of John and Margaret Hatcher, was born at Cooperstown, Illinois, October 11, 1861, but at an early age was taken by his parents to Greene County, Iowa, where they settled permanently, and where he received his early education. As a boy, he provided for future college expenses by working as a coal-miner and what he observed in the mines directed his attention and interest to the problems of geology. In 1881 he entered Grinnell College, Iowa, and, after remaining there for three months, he became a member of Yale University, graduating in 1884. His undergraduate years were devoted to the study of the natural sciences, and especially to geology and botany. Some collections that he had brought with him from Iowa attracted the attention of the late Professor Marsh, who appointed Hatcher, immediately on his graduation, as his assistant and at once sent him to the western field to collect fossil vertebrates.

Thus began a career which was unrivalled of its kind, for Hatcher had a positive genius for that particular work, as is well known to all who have had the privilege of accompanying him in the field. Marvelous powers of vision, at once telescopic and microscopic, a dauntless energy and fertility of resource that laughed all obstacles to scorn, and an enthusiastic devotion to his work, combined to secure for him a thoroughly well-earned success and a high reputation. He may be said to have fairly revolutionized the methods of collecting vertebrate fossils, a work which before his time had been almost wholly in the hands of untrained and unskilled men, but which he converted into a fine art. The exquisitely preserved fossils in American museums, which awaken the admiring envy of European paleontologists, are, to a large extent, directly or indirectly due to Hatcher's energy and skill and to the large-minded help and advice as to methods and localities which were always at the service of any one who chose to ask for them.

Hatcher's uprightness and sincerity of

character, no less than his remarkable energy and persistence, attracted to him the admiration of many western men, by whom frequent tempting offers were made him to leave the unremunerative paths of science for the material rewards of business, but in vain. He would not seriously consider the abandonment of his chosen work for any reward whatever and he died in harness.

In 1887 he married Miss Anna M. Peterson, who, with four children, survives him.

Hatcher's work for Professor Marsh and the U. S. Geological Survey continued for nine years and though, in 1890, he was appointed an assistant in geology in Yale University, he kept up his field-work with unbroken success, amassing a very large part of the enormous and invaluable collections which are stored at New Haven and Washington.

He accepted, in the spring of 1893, a call to Princeton University as curator of vertebrate paleontology and assistant in geology and at once threw himself into his new duties with characteristic ardor. For the three summers of 1893–5 he conducted field-parties of students through large parts of Utah, Wyoming and South Dakota and, with all of his old interest and skill, gathered priceless collections of mammals from the Uinta, White River, Loup Fork and Sheridan beds, accomplishing wonders, in spite of the scanty resources which sadly hampered his plans. His students became his enthusiastic friends and admirers, glorying in the courage and devotion which overcame every obstacle, material or moral. In return, Hatcher took the warmest interest in his students, especially in those who were struggling against difficulties to secure an education; in the quietest and most unostentatious way he was continually devising effective means to help such students to help themselves and thus enabled them to continue their studies without any impairment of their self-respect.

The most important work which Hatcher undertook during his connection with Princeton was his exploration of Patagonia in the years 1896 to 1899. The plan was all his own and was not proposed to the geological department until everything was nearly ripe for action; he secured the greater part of the necessary funds and, with characteristic generosity, was himself a liberal contributor. How successful this great undertaking was is very generally known and needs not to be repeated here. Great credit for this success is due to Messrs. Peterson and Colburn, who were associated with Hatcher in the work, but the soul of the enterprise was Hatcher himself. In his 'Narrative of the Expeditions' he has left an extremely well-written and interesting account of these explorations, which, however, gives the reader but an inadequate conception of the difficulties and perils which beset him, and of the boundless energy and courage with which those difficulties were met and overcome. Painful wounds, dangerous sickness, indescribable suffering, the hardships due to a severe climate and a savage wilderness and to inadequate equipment, in vain combined to turn him back, though he was twice compelled to return home for short periods of rest and recuperation. In the history of scientific exploration there are few chapters recording truer heroism and achievement than Hatcher's journeys through Patagonia.

The principal object of the expeditions was to gather the most extensive possible series of the fossil mammals for which Patagonia has been so famous since the days of Darwin's 'Voyage of the Beagle,' and next to determine the stratigraphical succession of the beds in which these fossils occur. This involved extensive explora-

tions of regions where no white man had ever been before and brought to light much geographical information. At the same time, the plants and recent animals were collected, so far as it was possible to do so without sacrificing the principal end in view, and in these departments also an unexpected measure of success was attained, and a representative series illustrating the botany, zoology and paleontology of Patagonia was secured.

Hatcher then conceived the plan of publishing together in one uniform series of reports, by the hands of different specialists, all these results, which would otherwise necessarily appear in separate form, scattered throughout the various technical journals. This plan was submitted to Mr. J. Pierpont Morgan, and to his liberality it is due that this cherished scheme is now in process of realization and in a manner surpassing the hopes of its original proposer. In addition to the 'Narrative and Geography,' Hatcher had undertaken to write reports upon the geology and also upon the fossil Litopterna and Marsupialia. How much of this material can be put into shape for publication can not yet be told. In any event, he has raised for himself an enduring monument in these volumes, which owe their existence to him, however much or little may be his verbal contribution to their contents.

Hatcher finally returned home (little as he believed it to be a final return) in the autumn of 1899 and in the following February he accepted a position as curator of vertebrate paleontology in the Carnegie Museum at Pittsburg, a position which he occupied till his death. With undiminished interest and zeal he took up the larger and more exacting duties of his new sphere and conducted his work with distinguished success. Paleontologists all know with what remarkable rapidity the collections of the Carnegie Museum have grown within the last four years and what a wealth of noble material has been brought together there, much of it unsurpassed in the world. No less than three great collections thus owe their choicest treasures to the skill and devotion of Hatcher.

It would, however, be creating a very false impression to let the reader suppose that Hatcher was entirely or even mainly a collector. For a long time he modestly held back from bringing his own observation and inferences before the scientific world and from this comparative seclusion he was late in emerging. He had been well trained and he had enjoyed great experience in years of field-work over a vast territory in two continents; more than this, he possessed a singularly original and independent mind and the keenest powers of observation, and these gifts, combined with his wide opportunities, led him to many novel and important conclusions in dynamical and stratigraphical geology, only a very small part of which has yet been published. The paleontology of the vertebrates was the field in which he took the deepest interest and in which he has published most, his papers dealing principally with mammals and reptiles. These papers show the ability which he brought to his subject and there seemed every reason to hope that his unresting activity might continue for many years and that the harvest would correspond to the long and laborious period of preparation. But this hope has been denied; Hatcher was cut off just when his powers and opportunities had reached their fullest development and the boundless field, in which he so loved to work, lay open and unrestricted before him. When his last illness attacked him, he was engaged upon a monograph of the Ceratosauria for the U. S. Geological Survey, upon the monographs for the Patagonia

Reports above mentioned, as well as upon several papers for the publications of the Carnegie Museum.

It is a pathetic coincidence that the words which Dr. Dall applied in this journal to the late Professor Beecher should so soon find an exact application to Beecher's former colleague in the Yale Museum: 'The ranks of those capable of bringing to the study of fossils keen insight and a philosophical spirit of inquiry, guided by principles whose value can hardly be exaggerated, are diminished by one whom science could ill afford to lose, and to whom, humanly speaking, there should have remained many years of industry and fruitful research.' W. B. Scott.

Princeton University.

SCIENTIFIC BOOKS.

Adolescence; its Psychology and its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education. By G. Stanley Hall. New York, D. Appleton and Company. 1904.

The range of President Hall's two volumes is even wider than the title announces. Besides the topics there indicated, the book contains an outline of the author's general psychological system, a philosophical *credo*, and multitudinous comments on the psychology of early childhood and adult life. The thirteen hundred and more pages are somewhat evenly divided among physical, psychological, social and miscellaneous phenomena. The author's division is as follows:

Volume I.—Growth in height and weight, 50 pages; growth of parts and organs during adolescence, 78 pages; growth of motor power and function, 108 pages; diseases of body and mind, 88 pages; juvenile faults, immoralities and crimes, 86 pages; sexual development: its dangers and hygiene in boys, 61 pages; periodicity, 41 pages; adolescence in literature, biography and history, 77 pages.

Volume II.—Changes in the senses and the voice, 39 pages; evolution of the feelings and instincts characteristic of normal adolescence, 55 pages; adolescent love, 49 pages; adolescent feelings toward nature and a new education in science, 88 pages; savage pubic initiations, classical ideals and customs and church confirmation, 49 pages; the adolescent psychology of conversion, 82 pages; social instincts and institutions, 86 pages; intellectual development and education, 112 pages; adolescent girls and their education, 87 pages; ethnic psychology and pedagogy, or adolescent races and their treatment, 101 pages.

The student will naturally divide the book as a whole into: (1) An array of facts bearing upon its topics, (2) an attempt to establish a parallelism between the mental development of human individuals and that of the whole phylum at one extreme of which they stand and (3) the author's educational recommendations. The reviewer will follow this division.

The array of facts presented implies an astonishing labor in reading, selecting and condensing. Over two thousand writers are quoted or referred to. Whoever has made any pretense of saying a scientific word about the rich life of concrete human nature, we may expect to find summarized. Be it the love of children for cats or growth of thoracic capacity or the lives of the saints, President Hall is equally ready with varied comment and plenteous references. No one person could estimate the completeness, accuracy and relevancy of this body of information as a whole. If the citations and summaries under each topic do represent adequately the views of the experts, President Hall's tremendous zeal will result in a corresponding saving of time and gain in insight for future students. If they do not, very many will be misled. In any case the array of information will, in these volumes as in the author's teaching, stimulate and suggest. In those fields where the reviewer could presume to judge, there appears an unhappy tendency toward the selection of authors and extracts which fit President Hall's own prepossessions. And this suspicion is too frequently confirmed in cases where expertness is not requisite. We tend to lose confidence in no matter how eminent a scholar, when, in a description of 'Adolescence in Literature and Biography,' he gives a thousand words to a summary of Mary Mc-

Lane and not one to the masterly descriptions of youth by George Meredith; or when he brushes aside James's 'Varieties of Religious Experience' as the work of a 'brilliant litterateur' who 'lays on colors with a trowel' and 'throws scientific caution to the winds.'

It was to be expected that the author would use, at their face value, the replies to printed questions written by children and normal school students and those interested enough to reply. Although he is probably the only one of the score of most eminent psychologists who put any trust in such replies, President Hall's confidence is serene and he does not even deign to justify his choice of a method so universally rejected by his peers.

The second chief aim of the book, to show how human life in general and adolescent mind in particular demand a comparative and genetic psychology as their explanation, is fulfilled to the extent of demonstrating and richly illustrating the fact that human nature in mind as in body bears traces of its long savage and animal ancestry. Although the author is, perhaps, brutal in his reproaches against the mere analysis of mental states, he is surely right in asserting the need of a true natural history of mind and in seeking to base theories of human behavior upon a dynamic rather than a static psychology. So much is irrespective of the particular connection which he believes to exist between human mental life as we know it to-day and the mental history of the long line of our ancestors; namely, the recapitulation by the individual of his phylum's evolution. It is impossible for the reviewer to discover just what the recapitulation theory means to President Hall. At times he seems to agree with the thoroughgoing parallelism stated by G. H. Schneider a score of years ago; at times the logical outcome of his concrete illustrations can be hardly more than a general continuity between human and animal instincts and capacities. In general he may fairly be said to explain any similarities between present and ancestral conditions by a recapitulatory tendency rather than by similarity in conditions and to seek constantly for such similarities. Many of his explanations are so purely speculative as to weaken his argument. One is amused more than edified by reading that the 'candle-light fever,' the excitement of children before bed-time, may be 'the reverberation in modern souls of the joy that in some prehistoric times hailed the Prometheus art of controlling fire and defying night.' And what can he mean by offering as evidence of mental recapitulation of a piscine stage the fact that the whales and others have changed from terrestrial to marine life (see Vol. II., p. 195)? And does not the argument become a trifle intricate when the fear of water and the love of water and the sitting 'by the hour seeing and hearing the movements of water in sea and stream' all prove recapitulation?

President Hall's educational recommendations will be read by many who will skip his summaries of facts and misunderstand such of his psychological speculations as they do not forget. They are the most personal and heartfelt portions of the book, with the exception of the eulogy of adolescent love, and will refresh many a student wearied by modern pedagogy. His fundamental principles are sufficiently startling. The tendency of evolution, in other words, the probable future, should be the goal of human effort. Morality is simply being up to and ahead of the times. The survival of a race proves the moral fitness of the individuals composing it; therefore, educate people to survive and propagate. You thus improve them. Delay the age of nubility, because the germs inherit the acquisitions of the individual, nay more, inherit the natures of previous ancestors only as the individual reacquires them. The latest stage in evolution is your goal, but omit no one of the earlier stages, for each is a *sine qua non* for the next. To be rid of a trait in later life cultivate it for a time in youth. But if you don't dare to let children be cruel and quarrelsome, at least let them contemplate these traits in literary or dramatic presentations.

In concrete recommendations the influence of this amazing creed is outweighed by that of President Hall's great practical wisdom and sharpest insight into the follies of our present traditionalism. The readers of this journal deserve, in the case of his comments on sci-

ence in the schools, a more detailed review than has been possible of the book as a whole. "Science should be taught first in a large, all-comprehensive way, not without a distinctly religious spirit." In childhood and youth we should encourage the 'sentimental response' to nature. Then should come popular science with many object lessons and stories of the heroes of science. Then the applications of science; 'the practical technological side of science should precede its purer forms.' 'Last and highest comes pure science.' For example, in physics teach boys and girls much about the heroes of science and the drama of research, diminish quantitative work, be more superficial for the sake of harmony with the recapitulation theory, make large use of mechanical toys, photography and the like. Let astronomy declare the glory of God rather than of precise measurements. Let biology emphasize life activities and the general theory of evolution. In general President Hall's destructive criticism of present high school text books of science, in which the man of science seems to postulate that what he happens to know and be interested in is what school-boys should learn, is stronger and will be more profitable than his positive suggestion that we revert to the personification of animals, ecstasies over nature and the goodness of God, and superficial cosmologies. The superficial cosmology has, perhaps, more in its favor than the present generation of men of science will admit. But it seems to entail rote memorizing as a method of study.

Two general features of the volumes, one of content and one of style, it is the reviewer's duty to note. The acts and feelings, normal and morbid, resulting from sex are discussed in a way without precedent in English science. To realize the material presented one must combine his memories of medical text-books, erotic poetry and inspirational preaching. Witness the following: "Every gemmule is mobilized and the sacred hour of heredity normally comes when adolescence is complete in wedlock and the cerebro-spinal rings up the sympathetic system, and this hands over the reins to the biophores and germ cells, which now assert their dominance over those of the soma. In the most unitary of all acts, which is the epitome and pleroma of life, we have the most intense of all affirmations of the will to live and realize that the only true God is love, and the center of life is worship. Every part of mind and body participates in a true pangenesis. This sacrament is the annunciation hour which the whole world reflects. Communion is fusion and beatitude. It is the supreme hedonic narcosis, a holy intoxication, the chief ecstasy, because the most intense of experiences; it is the very heart of psychology, and because it is the supreme pleasure of life it is the eternal basis and guarantee of optimism. * * *

"Reproduction is always sacrificial. Man learns to live by dying and his life is at best a masterly retreat. Relaxation and detumescence are the first faint symptoms from afar of senile involution and the Nemesis of death, toward which the individual shrivels. After the high tide in which the *ars amandi* culminates, lifting existence, like the great bore on the Chinese rivers, the law of *post coitum triste* is gradually accentuated with increasing years. Now man truly knows good and evil, euphoria and disphoria, and is polarized to pleasure and pain."

The feature of style is a baffling junction within the same paragraph, or even sentence, of statements which to the commonplace mind have no logical connection. The extraordinary range and vivacity of the author's interests are probably the cause. But some sacrifice should have been made to the commonplace thinker who will puzzle long and, perhaps, in vain to see the unity or logic of the hundreds of passages like the following: "The chief reason why our Bible is the best of all ethnic Bibles is because it is so deeply based upon genetic truth. The story of creation is full of ancient and subtle symbols of divine generation. The tale of Eden and the fall, whatever historic validity it may or may not have, is a masterly allegory of the first stage in the decadence of love. Abraham, a nomad sheik, was a breeder of cattle, and the promise was that he should be a breeder of men like the stars of the heavens for multitude. Circumcision was a hygienic measure of great

efficacy, as we shall see, as well as a covenant. The long wars with the Canaanites and Baal worshippers were conflicts with phallicism, to the gross orgies of which the chosen people were always lapsing. All early Hebrew history shows that while man knows how to breed cattle, Jehovah could breed men, and it is a study of human heredity far more effective than Plato knew how to make it. The New Testament begins with the annunciation and conception from on high, and a nursery scene of moving bucolic power, while Islam hypostatizes only the former." And what strength is added to a eulogy of wrestling by the last clause of this sentence: "The very closeness of body to body, emphasizing flexor rather than extensor arm muscles, imparts to it a peculiar tone, gives it a vast variety of possible activities, developing many alternatives at every stage, and tempts to many undiscovered forms of mayhem." These two samples were taken practically at random, but one puzzling association so rings in the reviewer's ears that he must allow it a motor discharge. It concerns the psychology of prison life and is, "Not only men, but women fall* in a school-girl mash, but women can not organize or complot."

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SCIENTIFIC JOURNALS AND ARTICLES.

THE leading article in the *Journal of Comparative Neurology and Psychology* for June is 'An Enumeration of the Medullated Nerve Fibers in the Ventral Roots of the Spinal Nerves of Man,' by Charles E. Ingbert, a direct continuation of the same author's former enumeration of the dorsal root fibers of man. An extensive discussion of the areas of the cross-sections of each root, the number of fibers per square millimeter of the cross-sections and the relation between the dorsal and ventral roots is followed by figures and tabulations giving the data for each fascicle of each nerve root. There are 203,700 medullated nerve fibers in the ventral roots of the left side and 653,627 in the dorsal roots, these numbers being in the ratio of 1:3.2. In the white rat this ratio is 1:2.3 and in the frog 1:1.2, indicating that probably the relative sensory supply increases as we ascend in the zoological series.

* The actual text is *pall*, which to the reviewer makes a truer statement, but the context suggests the correction.

SOCIETIES AND ACADEMIES.

THE TORREY BOTANICAL CLUB.

THE meeting of May 10, 1904, was held in the library of the New York College of Pharmacy, Rev. L. H. Lighthipe presiding.

The first paper on the scientific program was by Dr. H. M. Richards, entitled, 'Notes on the Peat Bogs of Ireland.' The peat bogs have been variously estimated as covering from one fifth to one tenth of the surface of Ireland; probably the larger estimate is excessive.

Dr. Richard's observations at several points on the west coast including Donegal and Achill Island were given. The basis of the bogs is not always the same, but in some cases it is glacial gravel. The thickness of the peat varies from one or two feet to forty feet, but no exposures of more than twenty-five feet thickness were seen. On the slopes and hillsides the peat is thinner, but becomes accumulated in the lower situations so that the thickness of the bog does not necessarily show its age. Bogs have been known to burst, as in Sligo, in 1831, and to do considerable damage to houses below them.

The peat is mostly vegetable matter and yields very little ash. According to Lyell, its formation is supposed to be due to the low temperature preventing complete decomposition of the vegetable matter. Peat is not formed in warm countries and the additions to the beds are made in cold weather. In the bogs seen there was standing water only in the holes and ditches, but the soil was wet and soggy. Comparatively little of the bog oak is found. Some of the stumps are in place, showing that they are not driftwood carried into the bog. The dark color and hardness of the bog oak are said to be due to the action of a diatom, a *Melosira*, and the formation of bog iron ore is supposed to be due to the same

diatom. It was suggested that part of this action may be due as well to *Crenothrix*. There is little of vegetable remains except at the top of the bog. *Sphagnum* makes up a comparatively small part of the peat bog vegetation as seen in the localities mentioned, and sphagnum peat is not so highly prized for fuel. A small *Carex* seemed to be the principal peat forming plant. Two species of *Drosera* grow in profusion and the heather and ling thrive very well and contribute considerably to the peat. *Pteridium* and several small ferns are rather common. *Sphagnum* and many fresh-water algæ grow in the holes and ditches, and from such places West has made fine collections of algæ, especially desmids. Peat bog soil has been found to be very sterile and at least two years are required to reclaim it, the method including throwing it up and exposing it to the air, and the application of fertilizers and lime. The cause of this sterility is not clearly understood, and is, perhaps, due to the lack of some of the necessary mineral salts and to the fact that the nitrogenous materials may not be in the best available form for plant nutrition. Some of the reclaimed peat bogs are very fertile lands, but if neglected they quickly run back to their sterile condition. If cultivation ceases, the *Pteridium*, heather and carices come back in a few years.

The second paper of the evening was by Dr. Marshall A. Howe, under title of 'Remarks on some West Indian Marine Algæ.' The remarks were based chiefly upon specimens collected by the speaker in March and April of the present year on the Florida Keys and the Bahama Islands, supplemented by specimens from Bermuda and Porto Rico and also by some obtained on a previous visit to Key West. The discussion was confined to the families Caulerpaceæ and Codiaceæ, members of the order Siphonales and class Chlorophyceæ. The family Caulerpaceæ, according to the more recent writers, consists of the single genus *Caulerpa*, with probably sixty or more well-defined species, including plants of a great diversity of form and habit. Some of the earlier phycologists, impressed by these evident differences, suggested generic segregations, and it is probable that some of the proposed genera are as well limited as are many of the current genera among the Agaricaceæ. There is, however, not such an unwieldy number of species to afford an excuse for generic splitting as is the case with the agarics, and there is practically nothing but habit and external form to lay hold of in limiting species and attempting generic segregations. Specimens were shown illustrating the principal sectional or subgeneric groups.

The Codiaceæ were illustrated by specimens of *Codium, Avrainvillea, Penicillus, Rhipocephalus, Udotea* and *Halimeda*. The genera *Penicillus* and *Rhipocephalus* are especially well represented in the Bahama Islands. Four species of *Penicillus* and two of *Rhipocephalus* were shown, all of which were found growing within a mile radius in Bemini Harbor, Bahamas. One of these is supposed to be the species described from the Bahamas by Decaisne in 1842 as *Penicillus oblongus* and apparently not met with in the meantime. This species was transferred to the genus *Rhipocephalus* by Kuetzing. In reality it stands between the genera *Penicillus* and *Rhipocephalus* and weakens the distinction between them. It is easily a *Rhipocephalus* when it is young, but as it gets older becomes more like a *Penicillus* and might then be casually passed by as a form of the common *Penicillus capitatus*. The head, however, is usually more oblong than in that species, the branching of the threads of the brush is characteristic and the arrangement of the threads in the apical or younger part of the brush is always distinctive.

Among the species and forms of *Halimeda* exhibited was one from the Florida Keys which is soon to be described as a new species. This has been confused with *Halimeda Tuna* by both American and foreign students of the genus, but is readily distinguished from that and other described species by the fact that the surface of each cortical tube or 'cell' is drawn out into a strong spine.

William T. Horne,
Secretary pro tem.

DISCUSSION AND CORRESPONDENCE.

THE METRIC SYSTEM.

TO THE EDITOR OF SCIENCE: I wish to add a hearty amen to what Professor Webster has said in SCIENCE, for June 3, 1904, in reference to the timidity of a few (a very few, I think and hope) of the friends of the metric system of weights and measures. As it is now more than a third of a century since I joined in an active dissemination of information regarding this system and an earnest advocacy of metrological reform through its adoption, and as I have enjoyed many opportunities for knowing the attitude of the people on this question, in various parts of the United States and at various times during these years, I hope I shall not be accused of extravagant or careless statement when I say that there are many more advocates of the adoption of the metric system in the country to-day than ever before, and that the opposition to it is not increasing, but everywhere steadily, and in some regions rapidly, decreasing. I will not undertake an elaborate proof of this statement, for it is quite unnecessary to do so and it will be generally admitted, I think, among those who have thoroughly investigated the subject. This sentiment is especially reflected in the general unanimity of opinion among representatives in congress, coming from all parts of the country and particularly in the *aggressive and well-organized opposition* that has developed within a few years. Indeed, nothing has been more encouraging to the friends of metrological reform than the rather sudden appearance of this not inconsiderable and always respectable mass of conservatism in battle array, for if the metric system can not stand under the most searching criticism or relentless opposition, then it ought to fall. Although it may be truthfully declared that there is not an argument against the adoption of the system that was not met and refuted more than twenty years ago, the recent publication of papers, pamphlets, letters, etc., in which the old objections have been restated and the old arguments bolstered up, has served a useful purpose in bringing their weakness to the attention of a larger audience. The people will understand after a while, and they are beginning to understand now, that the commercial interests of the country, both domestic and foreign, are bearing an enormous and wholly unnecessary load on account of the selfishness of a really small group of men engaged in a special industry, whose opposition is generally not due to any objection to the new system itself, but only to the alleged cost of substituting it for the old. In the meantime our great competitors in the world's activities have learned their lesson, most of them long ago; the only one still holding fast (with us) to this relic of barbarism, a thoroughly unscientific system of weights and measures, is just on the point of letting go. That we must follow in the near future is certain and all discussion, even including unreasoning opposition, must hasten the day.

It is of the greatest importance, however, that there should be no temporizing or 'arbitration' with the opposition to this, one of the most, if not the most, important economic reform yet brought to the attention of our people. It would be infinitely better to wait a few years longer (in which the inevitable operation of natural causes will greatly diminish the number of opponents) than to yield to any suggestion looking to the retention of the old units of lengths and mass or to *any* modification, in any essential feature, of the system as it is now in almost universal use among civilized nations.

There is a great necessity for a reform in the method of *using* weights and measures in ordinary commercial transactions, to which the metric system lends itself, and which will be one of the most important incidental advantages of its adoption. I refer to the more general use of weight instead of capacity measures. Practically, nearly every transaction involving quantity of matter can be better managed by weighing than by measuring; better, because nearly always far more accurately, and generally more conveniently. In the part of the world in which I am writing, the kilogram is practically the only unit used in dealing with all commodities, excepting, of course, textile fabrics and the like. There is nothing taking the place of the bar-

rel, bushel, peck, quart, etc., for apples, peaches, cherries, strawberries and berries of all kinds, potatoes, asparagus and, as far as I have been able to note, all vegetables and practically all fruits, except oranges (sold by count) are weighed out in kilos or grams. The man with the push-cart who peddles these things in the street always weighs them, and even the basket-man, whose entire stock in trade may often be bought for less than ten cents, carries his steelyard-like balance thrown over his shoulder. Indeed, I have never seen, as I have gone about the streets of Italian cities, in any of the many vegetable shops or other shops where food material is sold at retail, any other method of measuring quantity, barring a very few cases in which counting is used, as in dealing with eggs or oranges; even liquids are generally sold by weight and when a liter of anything is asked for it is usually weighed. This morning I happened to visit one of the largest grocery and food-supply houses in Florence. Among an almost infinite variety of products sold here there may be mentioned, peas, beans (dry), hominy, meal of various kinds, etc., alcohol, benzine, petroleum and very many other articles, all of which in the United States would ordinarily be sold by the quart, peck, gallon or other capacity measure.

The manager told me that all of these, even including wine in which he deals largely, are sold only by weight; that he had once had a single liter measure in his store which he had used for a time in measuring petroleum, but that he now has no capacity measure whatever in his entire establishment. In some shops petroleum is sold by volume, but in many others always by weight.

The use of weight instead of volume is a great benefit to the purchaser and is equally advantageous to the honest dealer, but it is only possible in a system in which the translation from mass to volume is quickly and easily made. Weighing can always be done with a much higher degree of accuracy than is possible with volume measuring, allowing the same time and care.

Cheating by means of false measures, or by correct measures loosely filled or 'topped,' is very common, and inspectors find it difficult to deal with. False balances and weights are much more easily detected. Then there is that large collection of most uncertain measures of extensive use but without the least legal standing, including the box, basket, crate, package, 'bunch' and the like, by means of which peaches, berries, etc., are retailed to a confiding public, the capacity of box or basket depending entirely on the disposition of the dealer and the scarcity of the commodity. It is worth a good deal to be protected from this sort of petty robbery.

T. C. M.

Florence, Italy,
June 17, 1904.

HONORARY DEGREES IN ENGINEERING.

To the Editor of Science: For several years our technical press has called attention after each commencement season to the disproportionately small number of engineers among those whose attainments receive the sanction of academic approval in the form of honorary degrees. The *Street Railway Journal*, the exponent in America of the most progressive branch of electrical engineering, calls attention to this unsatisfactory state of affairs in its issue of July 16.

The value of education is to a very great extent realized in service, and there is no better indication of true appreciation of the ends of education on the part of our institutions which are devoted mainly to the beginnings of it than the conferring of honorary degrees wisely.

Our universities, to the extent that they stand for research, have an end in themselves, and academic honors are promptly bestowed upon those who contribute to the advancement of learning. Our colleges and technical schools, on the other hand, are devoted almost exclusively to teaching and they have no end in themselves. No college teacher can draw much inspiration from the meager attainments of his untried graduates. The fruit of his labor is extra-academic, and the effectiveness of his labor depends upon his being sufficiently a man of the world to know these fruits and to draw his inspiration from them. If the

granting of honorary degrees by our colleges to men outside of academic life has any reason to be, and surely it has, it is because such academic recognition is an expression of appreciation on the part of the personnel of the college of the things in which alone the results of their labors take on the garb of reality. As an expression of this kind of appreciation the function of the college in the granting of honorary degrees contributes vastly more to the credit of the college when wisely performed than to the sum of honor that rests upon those who do the world's work and carry its heavy dignities.

Quite the most absurd notion respecting this conferring of honorary degrees is the more or less confused idea of many a circumscribed academician that it is the making rather than the marking of a distinction; and growing out of this pitifully foolish idea is the exaggerated dread of the prostitution of this really vital function of our academic institutions.

Let one read the words of President Van Hise (SCIENCE, July 15, p. 92) and consider whether anything could be more stimulating to a group of young graduates at a time when everything conspires to awake in them the most serious emotions. If the granting of honorary degrees is not a vital function it may easily be made such, and as such its greatest, perhaps its only benefit would accrue to the institution performing it.

It is a general impression, and perhaps it is true, that the number of engineers is disproportionately small among those who at each commencement season receive honorary degrees. If it is true, it is to be hoped that some of our larger schools of engineering may consider it. In any case it would be appropriate for our Society for the Promotion of Engineering Education to look into the matter.

W.

'PTERIDOSPERMAPHYTA.'

TO THE EDITOR OF SCIENCE: In proposing the name 'Pteridospermaphyta' (SCIENCE for July 1, 1904, p. 25), Professor Lester F. Ward does not seem to have noticed that Oliver and Scott have published 'Pteridospermæ' as the name of the group, in a paper presented to the Royal Society, January 21, 1904, entitled 'On the Structure of the Paleozoic Seed *Lagenostoma Lomaxi*, with a Statement of the Evidence upon which it is Referred to *Lyginodendron*.' Abstract preprints of this paper were distributed early in the year, were published prominently in *Nature*, 69: 334, February 4, 1904, and reviewed in the *Botanical Gazette*, 37: 237, March, 1904. The name was further established by Oliver in a paper entitled 'A New Pteridosperm,' published in the *New Phytologist*, 4: 32, January, 1904, and also reviewed in the *Botanical Gazette* (*l. c.*).

It was proposed by Oliver and Scott to establish 'a distinct class,' under the name Pteridospermæ, to 'embrace those paleozoic plants with the habit and much of the internal organization of ferns, which were reproduced by means of seeds.'

JOHN M. COULTER.

SPECIAL ARTICLES.

AUTOTOMY, REGENERATION AND NATURAL SELECTION.

HISTORY warns us that it is the customary fate of new truths to begin as heresies and to end as superstitions; and as matters now stand it is hardly rash to anticipate that in another twenty years the new generation, educated under the influences of the present day, will be in danger of accepting the main doctrines of the 'Origin of Species' with as little reflection and it may be with as little justification as so many of our contemporaries twenty years ago rejected them. —Huxley, 1880.

Huxley's prophecy has not been quite fulfilled, for the fate of natural selection as a scientific account of organic adaptations still depends on the testimony of witnesses. Nevertheless, the warning of 1880 is a wholesome stimulant to take before considering some recent objections that selection accounts neither for the process of self-mutilation, so common among the crustacea, nor for the ability of living things in general to repair injuries by the restoration of lost parts.

These two processes, autotomy and regeneration, have been studied by those who consider

them evidence in favor of selection, as well as by those to whom Darwinian explanations seem absurd. In this latter group is Professor T. H. Morgan, whose books, 'Regeneration' and 'Evolution and Adaptation,'* assert the inadequacy of selection. As the work summarized in the first volume has inspired the point of view from which the second one was written, a careful criticism of the former is a test of the soundness of the latter. Such criticism is difficult, not only from the nature of the subject, but especially because of a paradoxical frame of mind due to my agreement with Professor Morgan's main contention without being able to accept his own reasons for it.

Autotomy.—Professor Morgan regards the process of autotomy as a fatal stumbling block for the theory of natural selection. Thus on page 155 of 'Regeneration' we read:

> Even if it were granted that the theory of natural selection is correct, it does not follow that all useful processes have arisen under its guidance. We may, therefore, leave the general question aside, and inquire whether the process of autotomy could have arisen through natural selection (admitting that there is such a process for the sake of the present argument), or whether autotomy must be due to something else.
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> If we assume that the leg of some individual cray fishes or crabs, for example, broke off, when injured, more easily at one place than at another, and that regeneration took place as well, or even better, from this region than from any other, and if we further assume that those animals in which this happened would have had a better chance of survival than their fellows, then it might seem to follow that in time there would be more of this kind of animal that survived. But even these assumptions are not enough, for we must also assume that this particular variation was more likely to occur in the descendants of those that had it best developed, and that amongst those forms that survived, some had the same mechanism developed in a still higher degree, and, the process of selection again taking place, a further advance would be made in the direction of autotomy. This, I think, is a fair, although brief, statement of the conventional argument as to how the process of natural selection takes place. But let us look further and see if the results could be really carried out in the way imagined, shutting our eyes for the moment to the number of suppositions that it is necessary to make in order that the change may occur. It will not be difficult, I believe, to show that even on these assumptions the result could not be reached. In the first place, the crabs that are not injured in each generation are left out of account, and amongst these there will be some, it is true, that have the particular variation as well developed as the best amongst those that were injured, and others that have the average condition, but there will be still others that have the possibilities less highly developed, and the two latter classes will be, on the hypothesis, more numerous than those in the first class. The uninjured crabs will also have an advantage, so far as breeding and resisting the attacks of their enemies are concerned, as compared with those that have been injured, and in consequence they, rather than the injured one, will be more likely to leave descendants. Even if some of those that have been injured, and have thrown off the leg at the most advantageous place, should interbreed with the uninjured crabs, still nothing, or very little, can be gained, because, on Darwinian principles, intercrossing of this sort will soon bring back the extreme variations to the average.
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> The process of natural selection could at best only bring about the result provided all crabs in each generation lose one or more of their legs, and amongst these only the ones survive that break off the leg at the most advantageous place; but no such wholesale injury takes place, as direct observation has shown. At any one time only a small percentage, about ten per cent., have regenerating legs, and as the time required completely to regenerate a leg, even in the summer, is quite long, this percentage must give an approximate idea of the extent of exposure to injury. It is strange that those who assert offhand that, because autotomy is a useful process, therefore it must have been acquired by natural selection, have not taken the pains to work out how this could have come about. Had they done so, I can not but believe they would have seen how great the difficulties are that stand in the way.
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> A further difficulty is met when we find that each leg of the crab has the same mechanism. If we reject as preposterous the idea that natural selection has developed in each leg the same structure, then we must suppose that a crab varies in the same direction in all its legs at the same time; and if this is true it is obvious that the prin-

* 'Regeneration,' by Thomas Hunt Morgan, The Macmillan Company, New York, 1901. 'Evolution and Adaptation,' by Thomas Hunt Morgan, The Macmillan Company, New York, 1903.

ciple of variation must be a far more important factor in the result than the picking out of the most extreme variations. The same laws that determine that one individual varies in a useful direction farther than do other individuals may, after all, account for the entire series of changes. If it be replied that natural selection does not take into account the causes of the differences of individual variation, this is to admit that it avowedly leaves out of account the very principles that may in themselves, and without the aid of any such supposed process as natural selection, bring about the result. The Lamarckian principle of use and disuse does not give an explanation of autotomy, since the region of the breaking-joint is not the weakest region of the leg, or the place at which the leg would be most likely to be injured.

We can not assume autotomy to be a fundamental character of living things, since it occurs only under special conditions, and in special regions of the body. While it might be possible to trace the autotomy of the legs of the crustacea, myriapods and insects, to a common ancestral form, yet this is extremely improbable, because the process takes place in only a relatively few forms in each group. The autotomy of the wings of white ants that takes place along a preexisting breaking line must certainly have been independently acquired in this group. The breaking off of the end of the foot in the snail helicarion is also a special acquirement within the group of mollusca.

Bordage has suggested that the development of the breaking joint at the base of the leg of phasmids has been acquired in connection with the process of moulting. He has observed that during this period the leg can not, in some cases, be successfully withdrawn through the small basal region; and hence, if it could not break off, the animal would remain anchored to the old exoskeleton. It escapes at the expense of losing its leg. The animal, having acquired the means of breaking off its leg under these conditions, might also make use of the same mechanism when the leg is held or injured, and thereby escape its enemy. The fact that the crayfish has a breaking joint only for the large first pair of legs would seem to be in favor of this interpretation, but the crab has the same mechanism for the slender walking legs that one would suppose could be easily withdrawn from the old covering. It should also be remembered that we do not know whether the breaking joint at the base of the leg of the crab and of the crayfish would act at the time when the leg is being withdrawn from the old exoskeleton, unless the leg were first injured outside of the joint.

Our analysis leads to the conclusion that we can neither account for the phenomenon of autotomy as due to internal causes alone in the sense of its being a general property of protoplasm, nor to an external cause, in the sense of a reaction to injury or loss from accident. There would seem then only one possibility left, namely, that it is a result of both together, or in other words, a process that the animal has acquired in connection with the conditions under which it lives, or in other words, an adaptive response of the organism to its conditions of life.

We are not, however, able at present to push these questions farther, for, however probable it may seem that animals and plants may acquire characteristics useful to them in their special conditions of life, and yet not of sufficient importance to be decisive in a life-and-death struggle, still we can not, at present, state how this could have taken place in the course of evolution. For, however plausible it may appear that the useful structure has been built up through an interaction between the organism and its environment, we can not afford to leave out of sight another possibility, viz., that the structure or action may have appeared independently of the environment, but after it appeared the organism adopted a new environment to which its new characters made it better suited. If the latter alternative is true, we should look in vain if we tried to find out how the interaction of the environment brought about the adaptation. The relation would not be a causal one, in a physical sense, but the outcome of a different sort of a relation, viz., the restriction of the organism to the environment in which it can remain in existence and leave descendants.

For one whose life consists of a struggle for existence, it is difficult to appreciate the delicate humor with which Professor Morgan 'admits' natural selection for the sake of argument; it is more difficult for him to understand the objection that variations are not fit until they have been fitted into some part of the external world; but it is harder yet for him to see that 'the restriction of the organism to the environment in which it can remain in existence and leave descendants' differs from 'natural selection' except in the number of words used to express the same idea. These minor points, however, have little bearing on the evidence from autotomy. To appreciate

the value of this evidence it is necessary first of all to disentangle the fact that the crab has a mechanism to facilitate self-mutilation, from the fact that the mutilated parts are restored. This distinction is not only easy to make, since the legs regenerate at other levels, but it is also very important. One who recognizes the independence of these two facts does not hold the foolish opinions attributed to him any more than he accounts for his ability to mend a broken clavicle by referring to gifted ancestors whose success in life depended on the frequency and completeness with which they broke their collar bones.

The separation between the fact that there is a mechanism for throwing off legs, and the fact that the legs are regenerated from the point at which they are thrown off, leaves for consideration only the basis of the belief that the breaking joint is not of use to the species. The evidence for this belief is as follows: 'At any one time only a small percentage, about ten per cent., have regenerating legs, and as the time required completely to regenerate a leg even in the summer is quite long, this percentage must give an approximate idea of the extent of exposure to injury.' Thus the extent to which the mechanism is used is held to be too slight to account for its existence in the other ninety per cent. of the crabs. However, as this determination is only for 'any one time,' it falls into a class of statistical evidence which shows, according to Professor Brooks, that 'our subject matter lies midway between those exact sciences in which we are told that figures can not lie * * * and those social and political sciences which show us continually how easily one may lie with figures.'*

Granted that at any given time ten per cent. of crabs show that they have made use of the mechanism for throwing off their legs, this percentage gives no idea of the extent to which each crab uses the breaking joints during its entire life. How long a crab lives is not definitely known, but from analogy and indirect evidence five years is within the limit of life for some species. 'As the time required completely to regenerate a leg even in the summer is quite long,' it follows that in six months an appendage may regenerate completely.

Five years represent ten periods of six months. If in each period we were to count the ten injured individuals of a given hundred, then at the end of the full term we should have counted one hundred injuries, which, according to the doctrine of chance, would have been distributed among sixty-five individuals. Thus in five years, two out of three crabs would have been injured one or more times.

Regeneration.—Professor Morgan's book is one continuous protest that natural selection does not account for the ability of organisms to regenerate lost parts. Thus on the last page of 'Regeneration' he summarizes his convictions in the following words: "It seems highly probable that the regenerative process is one of the fundamental attributes of living things, and that we can find no explanation of it as the outcome of the selective agency of the environment. The phenomena of regeneration appear to belong to the general category of growth phenomena and as such are characteristic of organisms."

This demonstration, 'that the regenerative process is one of the fundamental attributes of living things,' seems valid; but to those who believe that natural selection is a law of nature, proof that the regenerative process is fundamental is likewise proof that natural selection has no bearing on this process. Natural selection is not an explanation of things ultimate any more than the law of falling bodies is an explanation of the fundamental characteristics of matter. No one holds that Newton's laws are invalidated because they do not explain the ultimate attributes of materials that fall, or of the space in which they fall, or why they fall in the order that we observe, because every one knows, or has known, that Newton's laws are merely records of events. Natural selection is the series of events which occurs in nature as the outcome of individual differences, the high rate of increase and the environment of living things. The charge, therefore, that this

* W. K. Brooks, 'The Intellectual Conditions for Embryological Science,' Science, XV., p. 488.

series of events does not explain one of the fundamental attributes of living matter is irrelevant.

An explanation of this curious misapprehension, as well as a remedy for it, may be found in the definition of regeneration as either the homomorphic or the heteromorphic replacement of lost parts, or the development of whole as well as imperfect organisms from pieces of adults, embryos or eggs. This definition leaves out of account a large class of true regenerative phenomena. Unless the term 'regeneration' has become a technical one, intended to convey only half of its legitimate sense, every restorative process should be included under it. It seems to me that if all anabolic processes were included in our common acceptance of the term, we should neither forget that the ability to regenerate is a fundamental attribute of living things, nor try to account for it by natural selection.

O. C. GLASER.

JOHNS HOPKINS UNIVERSITY.

CURRENT NOTES ON METEOROLOGY.

JAMES GLAISHER.

IN the *Quarterly Journal of the Royal Meteorological Society,* Vol. XXX., 1904, pp. 1–27, Mr. William Marriott, assistant secretary of the society, has a paper on the meteorological work of the late James Glaisher, F.R.S., whose death, in February, 1903, was duly noted in these columns. Glaisher was the founder of the Royal Meteorological Society in 1850. He had, in 1840, been appointed superintendent of the magnetic and meteorological department of the Royal Observatory, Greenwich. He soon became interested in and conversant with all kinds of meteorological investigations, and through his instrumentality numerous meteorological stations were equipped in various parts of the country. From 1847 to March, 1902, he supplied quarterly the results from those stations to the registrar general. He prepared various tables of corrections for the use of the observers, the principal of which were his 'Hygrometrical Tables,' which have passed through nine editions. He was a juror of the Great Exhibition of 1851, and as such he caused a great stimulus to be given to the manufacture of reliable meteorological instruments. Glaisher was best known to the public by the twenty-eight balloon ascents which he made for scientific purposes in the years 1862–1866, on behalf of a committee of the British Association. A bibliography of the writings of Glaisher is appended, and the statement is made that the instruments which he used during his balloon ascents have been given to the Royal Meteorological Society by his son. The last paper by James Glaisher appeared in the *Quarterly Statement of the Palestine Exploration Fund,* 1902, and is entitled 'Rainfall at Jerusalem in the Forty-one Years 1861–1901.'

THE DUST-FALL OF FEBRUARY, 1903.

'THE Great Dust-Fall of February, 1903, and its Origin' is discussed by H. R. Mill, R. G. K. Lempfert and J. S. Flett in the *Quarterly Journal of the Royal Meteorological Society,* Vol. XXX., 1904, pp. 57–88. The dust fell over nearly all parts of England and Wales to the south of a line drawn from Anglesey through Wrexham and Northampton to Ipswich, except in parts of northern Cornwall, Somerset, Wilts and Mid-Wales. At many stations to the north of this line the dust-fall did not attract the attention of observers, but is believed to have taken place on account of the distinct marks of yellow dust detected on the sunshine cards sent in to the Meteorological Office. The dust usually attracted attention either in the form of a dense yellow haze, like a London fog, or as a reddish-yellow powder, lying thickly on trees or roofs, or adhering to windows. There is reason to believe that the air which reached the southern half of England on February 22 started from the northwest coast of Africa on the nineteenth. Dr. Flett, who examined the dust microscopically, reports that the bulk of each specimen of dust presented to him for examination consisted of comparatively coarse particles of mineral and organic origin derived from the locality where it was collected. In addition to the coarser particles, all the samples contained a very fine-grained reddish clay, the particles of which were too minute

to be satisfactorily determined mineralogically. This clay was derived from some source beyond the British Isles, but it was not distinctive enough to afford much evidence as to its place of origin.

TEMPERATURE OF THE LOWER AIR.

In the *Meteorologische Zeitschrift*, XXI., 1904, pp. 49–62, Woeikof discusses the temperature of the lower air and the relation of this temperature to the temperature of the earth's surface. The vertical distribution of temperature in the ground is considered under two principal heads, 'I., The Sun, or Diurnal, Control,' and 'II., The Radiation, or Nocturnal, Control.' There are four types. The first (A) is characterized by a mean annual surface temperature higher than that further down. Where observations are available, and where this type is well developed, the surface is warmer than the air. In type B the temperature increases regularly from the surface downward; this may be called the snow type, and prevails where the ground is snow-covered for the whole year, or for at least three quarters of the year. In type C the temperatures of air and surface are uniform, and this occurs in moist, rainy districts of the middle and higher middle latitudes where there is no regular snow cover. Type D has a considerably higher mean annual temperature in the ground than in the air, and is, therefore, the rule in tropical and subtropical climates.

NEW MOUNTAIN OBSERVATORIES IN LAPLAND.

Nature of June 16, 1904, notes the successful establishment, by Dr. Hamberg, of Stockholm, of meteorographs at two high-level stations in Swedish Lapland. One of these, on the Portitjokko, at 1850 meters, has been working satisfactorily since July, 1902, with the exception of occasional interruptions of the anemometer owing to hoar frost. The second is on the Sähkok, at about 1,080 meters. Each set of apparatus weighs 1,000 kilograms. The clocks are to run for a year, the 'weights' being 300 kilograms each. Instead of using ink, which is unsatisfactory, punctures are made every twenty minutes in the papers covering the drums of the instruments.

NOTES.

Hann, in his 'Handbuch der Klimatologie,' second edition, Vol. III., pp. 249–250, gives a few notes on the climate of Manchuria, based chiefly on an article by Rev. John Ross in the *Scottish Geographical Magazine* for May, 1895. In *Ciel et Terre* for June 1, 1904, a summary of these same observations is given.

In the *Scottish Geographical Magazine* for June, Victor Dingelstedt describes the Crimean and Caucasian coasts of the Black Sea, finds them analogous in many ways to the Genoese and French coasts of the Mediterranean, and states the belief that these districts are about to be developed as a health resort for those who stand in need of a sojourn in mild climates.

The importance of the cyclonic control of our temperatures in the eastern United States in winter, and the dominance of the diurnal (*i. e.*, direct solar) control in summer, is brought out in a paper on 'The Temperature Element of the Climate of Binghamton, N. Y.,' in the *Monthly Weather Review*, XXXII., 1904, p. 78. The discussion of climate with due emphasis on the weather controls which bring about different types or extremes of temperature, pressure, wind velocity, etc., is a matter which deserves much more attention than it has yet received.

In a paper on 'Certain Relationships between the Diurnal Curves of Barometric Pressure and Vapor Tension at Kenilworth (Kimberley), South Africa' (*Quart. Journ. Roy. Met. Soc.*, XXX., 1904, 41–53), J. R. Sutton refers to the views of a number of leading meteorologists on the part played by vapor tension as a component of barometric pressure, and brings forward a series of observations at Kimberley designed to throw light on the still unsolved problem of the diurnal barometric wave.

Meteorological observations from the Arctic and the Antarctic are accumulating with remarkable rapidity. One of the latest additions to the collection from the Arctic is the series of four years' observations taken during the second voyage of the *Fram*, under Captain Sverdrup (Appendix IV., in 'New Land:

Four Years in the Arctic Regions,' by Otto Sverdrup; translated into English, 2 vols., London, 1904). R. DEC. WARD.

HARVARD UNIVERSITY.

NOTES ON ENTOMOLOGY.

As if we did not have enough names for the orders of insects, Mr. A. E. Shipley generously gives us seven more.* These are presented for the sake of having the names of all the orders terminate in '-ptera.' The new names are Apontoptera for Collembola, Lipoptera for Mallophaga, Ellipoptera for Anoplura, Psocoptera for Psocidæ, Embioptera for Embiidæ, Ephemeroptera for Ephemeridæ, and Paraneuroptera for Odonata. He appears to have overlooked the fact that the mayflies already had two '-ptera' names in Plectoptera and Anisoptera (Steph.). His new term, Ephemeroptera, has already been used in the same sense some fourteen years ago. If the terms Aptera and Neuroptera, which in the past covered all sorts of creatures, can now be applied to one order, why can not Archiptera or Pseudoneuroptera be restricted to the Odonata, and Synaptera to the Collembola; these latter names have had a much more exclusive membership. Nothing is done by Mr. Shipley with the Hemiptera, although it is nearly as heterogeneous as the Neuroptera of Linné. However, there are '-ptera' names (from 1835) for the four principal groups.

Now if the '-oura,' '-gnatha' and '-poda' partizans extend their nomenclature to the various orders, the requirements of science may be met.

A recent book by Georges Guénaux is a useful compendium of European economic entomology.† It forms a volume, in G. Wery's 'Encyclopédie Agricole.' About 100 pages are devoted to worms, the remainder to entomology. One chapter is devoted to structure and classification, then follow chapters on insects injurious to all crops, to cereals, to beets and clovers, to garden crops, to fruit trees, to the vine, to forest trees, to horticulture, in houses, to domestic animals and man, beneficial insects, destruction of injurious species, and myriapods and arachnids. The economic treatment is given with each injurious species. A great many of their remedial measures have been but little tried in this country.

Professor C. B. Davenport has given us an instructive account of the habits of certain Poduridæ affecting the sea-beach.* Three species inhabit the beach between high- and low-water marks. At high tide they are in the sand to a depth of six or more inches; as the tide falls they come to the surface and sport about on the pebbles. He interprets their almost continual jumping movements as useful to increase respiration, and shows that they leap into the wind, and not before it. When the tide rises they bury themselves in the sand, and Professor Davenport thinks that they feed, while thus submerged, upon particles of organic matter in the sand.

The peculiar wavy motion of centipedes has long excited even poetic minds to the wonder of how they managed to utilize all their legs in such a harmonious way. E. Ray Lankester has investigated the matter and arrives at several interesting results.† The legs move in groups or waves. Each wave includes a certain definite number of legs, apparently constant for each species. In the forms studied each wave contained from eight (in *Peripatus*) to sixteen members (in the millipede). The number of waves in a species depends upon the number of legs and the number of legs in the wave. He shows that in millipedes the waves of each side are opposite or synchronous, that is each leg of a pair moves just as its fellow. While in the centipedes each leg of a pair is in an opposite position from its fellow, so that the waves are symmetrically alternate. In the millipedes the body does not aid in locomotion, but in the centipedes the motion is partially due to the undulations or wriggling of the body. This fact indicates the more complex nature of the centipede.

* 'The orders of insects,' *Zool. Anz.*, XXVII., 259–262.

† 'Entomologie et Parasitologie Agricole,' Paris, 1904, pp. 580, figs. 390.

* 'The collembola of Cold Spring Beach, with Special Reference to the Movements of the Poduridæ,' Cold Spring Harbor Monographs, II., pp. 30, 1 pl., 1903.

† 'On the Movements of the Parapodia of *Peripatus*, Millipedes and Centipedes,' *Quart. Journ. Micr. Science*, March, 1904, pp. 577–582, 1 plate.

Professor Aug. Lameere, the eminent Belgian coleopterist, who has for some time been engaged in the praiseworthy work of revising the Prionides of the world, has issued a considerable portion of his monograph.* Abandoning older customs he has examined all available material in the European museums, and is thus able to furnish much synonymic matter. Each species is fully described, sometimes with ethological notes, and there are tables to the species of each genus. After each genus he has a chapter on the relationships and geographic distribution of the species.

Mr. J. E. Guthrie has prepared an account of the Collembola of Minnesota.† Fifty-eight species are listed. There are synoptic tables to the genera and species. Under each species is placed the original description, together with notes by the author; full synonymy is given, and there is a bibliography of works consulted. The plates illustrate the essential details of structure. It will be a very useful book, especially for one beginning the study of this neglected order of tiny insects.

The fourth volume of Tutt's exhaustive work‡ on the British Lepidoptera finishes the Sphingidæ. The thoroughness with which the multitude of details has been arranged in this work will never cease to excite wonder. Two species occupy together over 130 pages. With this volume there is published a synopsis of the contents and general index to Volumes I. to IV. In the preface Mr. Tutt gives an excellent criticism of the rules of nomenclature used by Rothschild and Jordan in their recent revision of the Sphingidæ. It may be noted that he uses *Sesia* in place of *Macroglossum*.

The *Annales du Musée du Congo*, which for some time has been published by the Belgian authorities, has commenced to treat of the insect fauna of the Congo region. Two portions have been issued; one on the group Prionides of the longicorn beetles, is by Professor A. Lameere; the other on the family Scutelleridæ of the Heteroptera is by Dr. H. Schouteden. The work appears in fascicles of folio size, and, if continued, will soon be a rival of the *Biologia Centrali Americana*. The plates appear to be fully equal to the best in that work.

E. Lynch Arribalzaga has described a new species of bird-grasshopper,* *Schistocerca peruviana*, which does considerable damage to cultivated crops in parts of Peru. It is closely related to several of the other destructive species, such as *S. peregrina* and *S. paranensis*, and more intimately to the American bird-grasshopper of our eastern states, *S. americana*. Nothing has been done in the way of remedial treatment.

In the same journal,† J. Brethes has given a revision of the South American Vespidæ, and of the Eumenidæ of the La Plata basin. Synoptic tables are given, and there are descriptions of many new species. E. L. Homberg in the same journal (pp. 377–512) describes a great number of new bees and fossorial hymenoptera, principally from Argentine.

NATHAN BANKS.

* 'Revision des Prionides, Macrotomines,' *Mém. Soc. Ent. Belg.*, XI., pp. 216, 1904.

† 'The Collembola of Minnesota,' Geol. and Nat. Hist. Surv. of Minn., Zool. Series, IV., Minneapolis, 1903, pp. 103, 16 plates.

‡ 'A Natural History of the British Lepidoptera,' Vol. IV., London, April, 1904, pp. 535, 3 pls., by J. W. Tutt.

THE INTERNATIONAL ELECTRICAL CONGRESS.

WE are informed that under the auspices of the Louisiana Purchase Exposition, an International Electrical Congress will be held in St. Louis during the week of September 12–17. The congress will be divided into two parts, namely:

(1) A Chamber of Government Delegates appointed by the various governments of the world, invitations to which were issued at the beginning of the year from the United States government. The transactions of the Chamber of Delegates will relate to matters affecting international questions of electrical units, standards, and the like.

* 'La Langosta Voladora del Peru,' *Anales Mus. Nac. Buenos Aires* (3), Vol. II., pp. 1–5, 1904.

† *Ibid.*, pp. 15–39 and 231–320.

(2) The Congress at large, divided into eight section, as follows:

General Theory: Section A, Mathematical, Experimental.

Applications: Section B, General Applications, Section C, Electrochemistry; Section D, Electric Power Transmission; Section E, Electric Light and Distribution; Section F, Electric Transportation; Section G, Electric Communication, Section H, Electrotherapeutics.

The president of the committee of organization is Professor Elihu Thomson, of Lynn, Mass. The vice-presidents are B. J. Arnold, Professor H. S. Carhart, Professor W. E. Goldsborough, C. F. Scott and Dr. S. W. Stratton.

Three hundred and forty-three official invitations were issued some months ago to well-known workers in electricity, inviting papers for the congress. 168 of these invitations were issued to persons residing in countries outside of North America. As a result of these invitations, 105 American and 59 foreign specially prepared papers are promised to the congress. Up to June 30, 1,787 adhesions to the congress had been received, of which about 1,300 have paid their subscriptions of $5.00 each. Of these, 291 are from countries outside of North America. The following societies will cooperate with the congress at St. Louis, by holding simultaneous conventions and joint sessions:

The American Institute of Electrical Engineers.
The American Electrochemical Society.
The American Physical Society.
The American Electrotherapeutic Association.
The Association of Municipal Electricians.

The following societies will cooperate with the congress by appointing delegates:

The National Electric Light Association.
The Association of Edison Illuminating Companies.
The Société Internationale des Electriciens.
The Schweizerscher Electrotechnischer Verein.

It is expected that various other European societies will also cooperate. Fourteen thousand six hundred invitations have been issued to persons interested in electricity all over the world, inviting them to join the congress. It is expected that the 'Transactions' of the congress will attain two or three large volumes. Persons interested in electricity and who desire to join the congress should apply to the general secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass. Each member of the congress is entitled to receive one set of the 'Transactions.' It is intended to issue the 'Transactions' of the congress, when printed, to libraries and non-members for $10.00 per set.

AMERICAN AND GERMAN UNIVERSITIES.

IT is interesting to note that of the 37,692 students enrolled in the German universities for the term now drawing to a close, 3,093 were foreigners, of whom 986 were Russians. Female students to the number of 1,314 were enrolled for the term.

These figures do not include such students as are merely guests (hospitants), of whom there are always quite a number. These enjoy all the privileges of the regular students, but they can not be graduated. If these be added to the others, it is safe to say that fully 10 per cent. of those attending German universities are foreigners. Almost one thousand Russians, or nearly one third of the foreign element, were matriculated last winter. Next come the Austrians and Hungarians, numbering 601, or about 20 per cent. Switzerland furnished 322 regular students, and there were 324 Americans enjoying the same opportunities.

The number of foreign students, especially of those coming from Russia, has steadily grown, but a careful study of the attendance at the German universities seems to show that Americans have not been adding to this increase. Thus, if we look over the reports of the winter half-year of 1899–1900, we find that the total attendance at German universities during that period was 32,834 regular students, of whom 2,369, or about 7 per cent., were foreigners; and that 607 of these were Russians, 455 Austrians, 265 Swiss, and 317 Americans. Thus there were only seven more Americans enrolled last winter than there were four years ago.

During the nineteenth century German universities led the world in erudition and scien-

tific investigation, and their great professors attracted many students from all parts of the world in quest of higher education. But times are altered. Having myself been engaged in educational work as an American college professor for a good part of my manhood, I have naturally taken considerable interest in the life and work at the various institutions of learning in this country, and it is my impression that the facilities for higher education are improving in the United States much more rapidly than in Germany. Despite all our imperfections one can not but admire the great upward strides which the American system of education, from the humble district school up, has been making during the last few decades.

American educational institutions are the best equipped in the world. I know but one German university that can claim to be up to the times in this regard, and it stands third in the list of attendance. There is a steady progress all along the line of public instruction in the United States, and particularly in our higher class of universities.

The regular reports of German universities will continue to show the attendance of American students. Though their number may not increase materially, still they come. And it is well that they should, particularly those that have in view special studies and investigations in certain lines; for Germany is preeminently the land of specialists, and it must be admitted that German devotion to special work has added immensely to the sum of knowledge. Besides, a year or two spent abroad can not but prove to be a great blessing to the average American student, not because he needs it to prepare him for his life's work, but because travel and sojourn in this and other countries are in themselves a liberal education, and tend to broaden the mind, widen the horizon, remove petty prejudices, and supply an independent judgment of men and matters. A few semesters at a German university, bringing a young man in touch with the ideas and methods of the great scholars and scientists of this country, as well as with the spirit of the German student's life, is an advantage generally appreciated all through life. But all this is rather a luxury than a necessity. No American need any longer come to this or go to any other country for higher education. In my judgment the United States offers to-day facilities for collegiate, academical and postgraduate studies equal in quantity and quality to those offered by any country in the Old World. Henry W. Diederich,

Consul.

Bremen, Germany,
June 10, 1904.

SCIENTIFIC NOTES AND NEWS.

The daily papers announce, we trust correctly, that Dr. Harry Tevis will establish in San Francisco an aquarium in honor of his father, the late Lloyd Tevis, which will be the finest institution of the kind in the world, the cost being $3,000,000 to $4,000,000. The aquarium will, it is said, be built in Golden Gate Park. Mr. John Galen Howard, supervising architect of the University of California, is preparing the plans.

Sir Joseph Dalton Hooker, the great British botanist, celebrated on June 30 his eighty-seventh birthday.

Dr. Kuno Fischer, professor of philosophy at Heidelberg, celebrated on June 23 his eightieth birthday.

Dr. Robert Koch has been made honorary professor of the University of Berlin as well as a member of the Academy of Sciences in succession to Virchow. There are only two other similar positions at Berlin, the one held by Professor Auwers, the astronomer, the other by Professor Van't Hoff, the chemist.

The Paris Academy of Sciences has elected as corresponding members M. Eugène Tisserand in the section of agriculture and Dr. E. Metschnikoff in the section of anatomy and zoology.

Dr. Pietro Blaserna, professor of physics at Rome, has been elected president of the Accademia dei Lincei.

It is stated in *Nature* that a committee has been formed in the Victoria University of Manchester to procure a portrait of Professor Osborne Reynolds, F.R.S., the senior member of the teaching staff, as a memorial of the

long and distinguished services which he has rendered to the Owens College and of his many valuable original contributions to physical science and engineering.

DR. H. S. JENNINGS, assistant professor of zoology in the University of Pennsylvania, has returned from the Zoological Station at Naples, Italy, where he has spent the past year conducting investigations on the behavior of the lower organisms as a research assistant of the Carnegie Institution.

MR. ROBERT T. HILL, late of the U. S. Geological Survey, has just returned from an extensive exploration trip in Mexico, which country he has been studying for many years, in order to ascertain its geologic evolution and history and relations to the geographic features of the United States and Central American region. Mr. Hill's address will continue to be 1738 Q Street, Washington, D. C.

MR. FREDERICK V. COVILLE, botanist of the United States Department of Agriculture, and Mr. Albert F. Potter, grazing expert of the Bureau of Forestry, have gone to the southwest grazing districts with a view to studying the ranges.

THE Mackinnon studentships of the Royal Society have been filled by the election of Mr. Bryan Cookson for research in astronomy, especially for a new determination of the constant of aberration, and Mr. L. Doncaster for work on the subject of variation and natural selection in plants and animals.

A BANQUET was given to Mr. Chamberlin, the well-known British political leader, on June 30, by the Royal Institute of Public Health, in recognition of his services to preventive and tropical medicine.

AT the second annual meeting of the British Academy, on June 29, Lord Reay was reelected president.

JEROME SONDERICKER, associate professor of applied mathematics at the Massachusetts Institute of Technology, died on July 22 at Wilmington, Vt.

DR. ISAAC ROBERTS, eminent for his work in astronomy, especially for his study of star clusters and nebulæ, has died at the age of seventy-five years.

THE death is also announced of Dr. L. Niemilowicz, professor of physiological chemistry at the University of Lemberg.

THE treasurers of the Institute of Medical Sciences Fund, London, have received the following additional donations: Lord Howard de Walden, £3,000; the Company of Fishmongers, 1,000 guineas; Dr. C. Theodore Williams £100.

THE British Medical Association is holding its seventy-second annual meeting at Oxford this week. Dr. G. D. Griffiths is the retiring president and Dr. W. Collier, the president-elect. The address in medicine is by Sir William S. Church and the address in surgery by Sir William Macewen.

THE Optical Society of London, of which Dr. R. T. Glazebrook is president, proposes holding an optical convention in London next year.

Nature states that a large deputation has waited on Lord Londonderry, president of the Board of Education, to urge the compulsory teaching of hygiene in elementary and secondary schools. The deputation was in support of a petition which has been signed by nearly fifteen thousand medical practitioners. The petitioners urged the central educational authorities of the United Kingdom to consider 'whether it would not be possible to include in the curricula of the public elementary schools, and to encourage in the secondary schools, such teaching as may, without developing any tendency to dwell on what is unwholesome, lead all the children to appreciate at their true value healthful bodily conditions as regards cleanliness, pure air, food, drink, etc.' The petitioners remark that a widespread ignorance prevails concerning not only the nature and properties of alcohol, but also its effects on the body and the mind. Central education authorities are therefore asked to include in the simple hygienic teaching desired elementary instruction at an early age on the nature and effects of alcohol. Dr. Farquharson, M.P., introduced the deputation, and short speeches in support of its objects were made by Sir W. Broadbent, Dr. D. Griffiths, Sir T.

Barlow, Sir Lauder Brunton, Sir Victor Horsley, Dr. Mary Scharlieb, Dr. Hutchinson and Professor Sims Woodhead. Lord Londonderry, in reply, said the proposals made by the deputation had his sincerest sympathy, and he only wished it was in the power of the board of education to carry them out. He was as anxious as any one to see increased instruction being given in the laws of health, but at the present time the necessary teachers did not exist, and he should be the last to wish anybody to act as instructor in such important subjects who had not received instruction in them. The board was at the present moment devoting itself to the training of teachers and instructing them properly in the whole question of hygiene. He trusted that as time went on its efforts in that direction would bring about the desired results.

THE appropriation of $1,500 recently made by the New York State legislature for cooperative hydrographic work with the U. S. Geological Survey will be used in maintaining records of the rise and fall, the ordinary outflow, floods and droughts of many streams in the state. By means of these records it is possible to determine in specific cases the water supply available for canals, public water systems and water power. The condition of streams in more than fifty places in the state is regularly reported. The work has gradually grown until there is at present hardly a section of the state in which some river is not systematically measured. The list includes Chemung, Allegheny, Susquehanna, Chenango, Catskill, Delaware, Hudson, Mohawk, Saranac, Oswegatchie, Genesee, Oneida, Seneca, Oswego and Black rivers and their most important branches. The developed water power of these streams amounts to nearly 300,000 horse power, and they afford an almost unlimited amount of undeveloped power. Mr. Robert E. Horton, hydrographer, of Utica, N. Y., has charge of the work.

WE learn from *Nature* that the Imperial Academy of Sciences of Vienna announces the following grants: To the Vienna Society for Solar Observation, 1,600 Krone for observations on climatic changes in the Goldberg glacier, and to Professor Ritter Beck von Managetta (Prague) 600 Krone for studies of plant distribution in the Julian Alps. From the Wedl bequest, to Drs. Obermayer and Pick (Vienna) 600 Krone for the chemistry of immune substances, to Dr. Moritz Probst 800 Krone for continuation of work on the brain, to Dr. Karl Camillo Schneider 400 Krone for a zoological expedition to Grado, to Professor Julius Tandler 1,000 Krone for studies in the development of birds. The committee of the Treitel legacy awards the following grants: To Professor Hans Skraup (Graz) 1,500 Krone for studies on albumens, to Dr. Franz Werner 6,000 Krone for a zoological expedition to the Egyptian Soudan, to Professor Julius Wiesner 4,000 Krone for effects of light on plant life in the Yellowstone district, to the Austrian Meteorological Society 4,000 Krone for investigations of the upper atmosphere, and to the Earthquake Commission 5,465 Krone 39 heller.

UNIVERSITY AND EDUCATIONAL NEWS.

DR. ALBERT FRÄNKEL, one of the leading German clinicians, who has been for twenty-seven years docent in the University of Berlin, has resigned. It is believed that his promotion to a professorship was withheld owing to the fact that he is a Jew. Dr. Hermann Oppenheim recently resigned under similar circumstances. He was unanimously recommended by the faculty for promotion, but the recommendation was not confirmed by the ministry.

DR. HENRY L. WOODWARD has been appointed assistant to the chair of physiology in the Medical College of Ohio, medical department of the University of Cincinnati.

AT the University of Leeds, Dr. J. B. Cohen and Mr. Percy F. Kendall have been appointed professors of organic chemistry and of geology, respectively.

DR. DÖRING has been appointed professor of analytical and applied chemistry at the University of Freiberg.

DR. KARL SCHEEL has been made professor and member of the German Reichsanstalt.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 5, 1904.

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THE STATE UNIVERSITY AND RESEARCH.*

IT is the privilege of the private school, the denominational institution and the independent university to select the phases of education to which they shall devote themselves; but the appropriate sphere of a state system of education is predetermined by the inherent relations which the state sustains. The function of all state institutions is the welfare of the commonwealth. By first intention, the state is not concerned with the individual, but with the aggregate body of its citizens. The state must necessarily deal with individuals, but rather as integers of the aggregate body than *as* individuals. State education, therefore, in the strictest construction, and in the highest ideal, is the education of the aggregate body that forms the commonwealth. Education from the view-point of other institutions may deal primarily with the individual, and only secondarily with the aggregate. State education deals primarily with the aggregate, and only incidentally with the individual as a constituent of the aggregate. Obviously I am defining the ideal rather than the actual fact of practice; rather of the goal to be at length attained than any present achievement.

In its earliest stages, formal education seems to have been altogether individual. Gradually it grew to be the privilege of select classes, and at length, but only at a late day and among the foremost peoples, it has come to be a possibility for all.

* One of the two convocation addresses given on the occasion of the semicentennial jubilee of the University of Wisconsin.

Parallel with this extension of personal privilege, there has been a growth in the breadth of the educational conception. The elevation of the aggregate intellectuality of the people has begun to succeed the narrower idea of the education of the individual simply. To paraphrase the immortal apothegm of Lincoln, primitive education was of the individual, by the individual, and for the individual. The state's ideal effort is the education of the commonwealth, by the commonwealth and for the commonwealth.

Lest this shall seem mere borrowed rhetoric, let us examine the fundamental source of education in the ulterior sense, as distinguished from the technical and narrow sense. It need not be affirmed that education is broader than 'schooling.' The development of mind and character begins before the school is entered, and continues long after the halls of learning are abandoned. Education is begun when thought, feeling and activity begin, and ceases only when thought, feeling and activity cease to be susceptible of modification. At all times, a large part of the educational influences lie outside the schools. Education is derived from every mental contact; it is absorbed from the whole intellectual environment; it is inspired by infinite sources of stimulus. The course in the schools are merely a limited selection from possible means, chosen for supposed effectiveness during the receptive and formative stages.

The *fundamental* and *ulterior* sources of education do not lie in the conventional schools, but back of them. These sources can not here be defined at length, but in a simple phrase, they may be said to lie in *the great stock of ideas possessed by mankind.* This phrase inadequately embraces the whole, but let us agree that it may stand for the whole. In so far as the stock of ideas of a people is narrow, defective and erroneous, on the one hand, or broad, demonstrative and exact, on the other, in so far the fundamental subject-material of education partakes of these qualities. In so far as the sentiments, beliefs, attitudes and activities of a people are narrow, loose and perverted, on the one hand, or free, generous and ethical, on the other, in so far education inevitably shares in these qualities. *For these are the fundamental sources of education.* The basal problem of education is, therefore, concerned with the entire compass of the intellectual possessions of a people, and, in a measure, of all mankind. The special selections propagated in the schools are but a miniature reflection of the total possession, and this selection is usually noble or mean, as the whole is noble or mean.

If these considerations are true, the *fundamental* promotion of education lies in an increase of the intellectual possessions of a people, and in the mental activities and attitudes that grow out of the getting, the testing and the using of these possessions.

In the education of the individual, the personality of the instructor counts for much. In the education of a people, the personality of a teacher is fused with the multitude of other, and often conflicting, personal influences, and, unless it be phenomenal, it is submerged. But determinate truths work together for permanent results. These results often lie athwart the trend of personal inculcations. True ideas work incessantly and unswervingly toward a destined end, while the thousand little waves of merely personal influence cross one another's paths and work one another's destruction. Determinate truth is radioactive, and sends forth a constant stream of penetrating, illuminating emanations, to which only the most leaden intellect is opaque. The discoverers of great truths and the authors of great ideas are the great educators.

The education of the individual does not necessarily lift the education of the aggregate, for if we convey to the rising generation only such ideas as we have inherited, the summit-level of education is not raised. There may be diffusion—there may be an evening up—but no lifting of the upper levels. If the intellectuality of the new generation does not rise above that of the old, there is only a Chinese dead-level of ancestral propagation.

If we are agreed upon this, let us turn to the question, *How is real educational advancement to be secured?*

Some progress may be made in a live people by voluntary research and by the incidental accretions of common experience, but if our intellectual estate be left to such sporadic and unsystematic agencies, growth is a creature of uncertainty. If perchance there be laudable growth, it is scant credit to the state. If the enrichment of our intellectual world be left to spontaneous individual action, it can not be hoped that it will be continuous or systematically directed. It will follow the diverse lines that chance to be inviting to individuals. Inquiries will be taken up and dropped at pleasure, and will be limited by scant resources. There is as good chance of finding a rich man in heaven as in a laboratory.

To secure laudable progress in the fundamental conditions of education, systematic provision for scientific research is requisite. By scientific research I do not, of course, mean physical research alone, but rigorous investigation in any field. To give this research its best adaptations to the needs of a people, it should be systematically controlled in the lines most tributary to these needs. To make the results available to all who will use them, suitable means for dissemination are requisite. Inevitably the highest intellectual training will grow out of this, for such training is both the prerequisite and the outcome of the struggle to find truth and to test it. Out of this training will come the best possible development of intellectual capacity, of right attitude toward truth, and of considerate action controlled by the scientific spirit.

With the majority of Wisconsin people I hold that it is a legitimate function of the state to train boys to be farmers, but I believe it to be a much higher and truer function to develop the science of agriculture, to increase the intellectual activity of every farmer, to improve the agricultural art on every farm, and by such improved art, to furnish better and safer food to every citizen. That such a result is not an idle dream need not be affirmed in Wisconsin. Gigantic steps towards its realization have already been taken. The material results you know, for they are tangible. The intellectual and moral results more easily elude recognition. I venture to cite a personal observation. It was my privilege to compare the agricultural conventions of this state at two periods separated by a decade, within which the experiment station became a potent influence. The dominant intellectual and moral attitude of the earlier period was distinctly disputatious and dogmatic. Opinions and floating notions played the part that should have been reserved for demonstrations. Interpretations were loose, and close analyses rare. In the second period, the dominant attitude was that of a scientific conference. Opinions were replaced by demonstrations, or by tentative hypotheses. Conviction was sought by the presentation of determinate facts, gathered by experiment and laborious observation, carefully analyzed and cautiously interpreted. The whole was characterized by a notable approach to the methods of approved scientific procedure. The intellectual and moral contrast of the two periods was one of the most pronounced expressions of advance in the higher education in a great mass of

people in the midst of practical life which it has ever been my privilege to witness.

If the state educates an engineer, it promotes the common safety, which is threatened by an ever-increasing multitude of new contingencies springing from new devices in construction, transportation, sanitation, electric lighting, *et cetera*. But if the state creates and spreads broadcast engineering science, it makes protective intelligence more nearly a common possession, and lays the groundwork for universal caution and for intelligent watch over every one who holds the power of life and death in his hands. The supreme function of the state's college of engineering is rather the creation and dissemination of engineering science than the personal training of a technologist.

If the state educates a physician, it confers a benefit on the commonwealth by so much as he contributes locally to the public health. But if the state investigates the cause of disease and the mode of prevention and cure, and propagates the results, every citizen, directly or indirectly, becomes a beneficiary, and the interests of the whole people are conserved.

Doubtless it is a proper function of the state university to train lawyers, for their public service is indispensable, but it is a higher function to develop the science of law-making. The subject matter now taught relates chiefly to the application and consequences of laws already enacted, and especially to the litigation that springs from their obscurities or defects. Should not the chief effort lie back of this in investigation precedent to law-making? With suitable provisions, the history of every law passed by the legislature may be traced by the methods of historical science, its workings measured with approximate accuracy, and its adaptation to its purpose scientifically determined. Similar determinations in other commonwealths are equally possible. Comparison between these, when sufficiently multiplied and critically discussed, should give a basis for determining the best mode of legislative treatment with something of the confidence that clinical records give to surgical or pathological treatment. The important function of law-making may be subjected to the same antecedent processes of scientific inquiry, of judicial induction, and of intellectual caution and equipoise that obtain in medicine, mechanics or agriculture. This may at present seem Utopian because of regnant practise and prepossession to the contrary, but, given the same patience and ingenuity, why may we not treat the history of laws in the same critical, deliberate way that the scientific pathologist treats the history of disease, or the scientific surgeon the history of an operation? It will not be denied that if the modes of scientific research controlled this field, so especially the function of the state, it would be as beneficent in its sphere as scientific pathology is in its realm, or the high art of surgery in its field. Beyond this historical treatment, there is the great untouched field of *systematic experimentation in legislation under scientific control*—but the next speakers would have good cause for action at court if I entered on this untrodden field.

These citations are merely illustrative selections. Research in every realm of a people's legitimate interests is an appropriate function of the people's *organized self*, the state, and of the people's *organized instrument of research*, the state university.

The people of Wisconsin are to be congratulated on the important initial steps already taken by their university towards the fulfillment of its higher sphere. They are to be warmly felicitated on the larger effort upon which the new administration of the university has already entered with so much of vigor and enthusiasm. They are to be congratulated on the acknowl-

edged ability of their new leader to direct the development of investigation in fruitful lines, an ability already eminently demonstrated by personal researches. It is a further ground of high hope that he adds to commanding ability and fruitful experience, so large and so true appreciation of the higher function of a state university.

Conscious of my personal partiality, I yet believe that in truth the University of Wisconsin is a leader among its class in this higher field of research. But no university has yet fully entered upon it. Which shall be the first to become predominantly an institution of research? Which shall be the first to fulfill the high destiny of an ideal state university? Citizens of Wisconsin, given the means and the moral support, your new educational chief will lead forward with gigantic strides your beloved institution into this upper and broader field of usefulness. Will the means and the moral support be forthcoming? T. C. CHAMBERLIN.

UNIVERSITY OF CHICAGO.

THE MOSELY EDUCATIONAL COMMISSION. II.

IN most American colleges the arts course occupies four years; in a few only is it possible to graduate in three years. At Harvard College, where the subject of the length of the course has long been under discussion, it has recently been determined to allow students to attain the bachelor of arts degree in three or three and a half years, instead of four years; but owing to the improvement in the courses of instruction it will be possible to require from candidates who obtain the degree in the shorter period evidence of higher scholarship than has been expected of their predecessors at the end of four years. The arts course at the Johns Hopkins University extends over three years; but the standard of matriculation is said to be considerably higher than that maintained by institutions which require a residence of four years. The question whether the professional schools of the universities shall require a degree in arts or science from all candidates for admission is now being much debated. There is clearly a strong desire to raise the standard. This is well expressed in the following passage from the report made by President Eliot, of Harvard, at the close of 1902:

> Since the wise and efficient conduct of American affairs, commercial, industrial and public, depends more and more upon the learned and scientific professions, the universities owe it to the country to provide the best possible preparation for all the professions. This best possible preparation can only be given to young men who up to their twenty-first year have had the advantages of continuous and progressive school and college training.

President Eliot gives the following table showing the proportion in nine universities in which law and medical students holding a preliminary degree stand to all students:

Universities.	Holders of a Preliminary Degree.	Whole Number of Law and Medical Students.	Per Cent. of Holders of a Preliminary Degree.
Harvard	886	1,134	78.1
Columbia	562	1,260	44.6
Pennsylvania	331	928	35.6
Northwestern	220	691	31.8
Michigan	216	1,367	15.8
Yale	119	398	29.9
California	118	269	44.0
Chicago (Med.) ...	100	325	30.7
Cornell	75	607	12.3

Harvard University "has definitely determined to pursue the policy of requiring for admission to its professional schools a preliminary degree and has already applied this policy in all its professional schools except the dental school. The result has been an improvement in its professional schools striking in proportion to the strength of the contrast between the former students and the present in regard to their previous training."

At the Johns Hopkins University, candidates for the degree of doctor of medicine must be college graduates or must give evidence by examination that they possess attainments indicated by a baccalaureate degree in arts or science. Entering college at eighteen, the student is twenty-one or twenty-two years old on commencing this course of professional study; he is, therefore, at least twenty-five or twenty-six at the conclusion of the medical course. A period of post-graduate instruction at home or abroad is then often entered upon. It is not unlikely that the example set by law and medicine will erelong extend to other professions. The undue length of the course of study thus arranged has naturally attracted attention. Recently President Murray Butler, in particular, has commented on it and has proposed a further curtailment of the course. There are instances of such curtailment already. Thus at Cleveland, Ohio, where the Adelbert College and the Case School of Applied Science exist side by side, each having a complete four years' course, it has been arranged to give a double degree at the end of five years to those who have spent three years in the college and then two years in the school of applied science. President Butler proposes that the B.A. degree given at the end of a two years' prescribed college course shall be made the condition of entry to a professional course. He would give the M.A. degree to those who have followed an arts course during four years.

It is remarkable that a people supposed to be practical, like the Americans, should be prepared to devote so long a period to study. I had many conversations on the subject, in which I expressed my surprise; but I must confess that, as a rule, my friends seemed surprised that I should take up such an attitude. I am almost led to doubt whether, in matters of education, our American cousins may justly be regarded as a practical people. A course of study prolonged to an age bordering on thirty rather than twenty implies a most serious limitation on the period during which the individual exercises independence; it casts an improper burden on parents; and it postpones the age of marriage unduly. This last point especially deserves some consideration. The following table, given by President Eliot in his report, records the number of surviving children of members of six classes graduated from Harvard, from twenty-five to thirty years after graduation:

Class of	Number of A. B.'s.	Number Married.	Number of Children Surviving, 1902
1872.....	114	82	165
1873.....	131	96	181
1874.....	165	124	247
1875.....	141	90	171
1876.....	142	106	212
1877.....	188	136	286
	881	634	1,262

He points out that:

If it be assumed that the surviving children are about one half males, it follows that the six classes have by no means reproduced themselves; that they have, indeed, fallen 28 per cent. short of it. Twenty-eight per cent. of the members of these classes are unmarried; and those who are married have, on the average, only two surviving children; so that the married pairs just reproduce themselves on the average.

It is impossible to overlook the significance of such facts. Again, to quote President Eliot:

The table suggests that the highly-educated part of the American people does not increase the population at all, but, on the contrary, fails to reproduce itself. If many other colleges and universities publish class reports analogous to the Harvard reports a competent statistician might establish from the assembled reports some interesting and important conclusions. It is probable that the regrettable result indicated in the table is due in part to the late postponement of marriage on the part of educated young men, a postponement which the protracted education now prescribed for

men who enter the learned and scientific professions makes almost unavoidable. The young physician, lawyer, engineer or architect is now fortunate if he marries at twenty-eight or twenty-nine; whereas he should have married at twenty-five or twenty-six. To make earlier marriage possible is one of the strong inducements for bringing to an end the school course at seventeen or eighteen, the college course at twenty or twenty-one, and the professional training at twenty-four or twenty-five.

Our blind belief in academic methods of training has, perhaps, led us to overlook yet other all-important reasons for shortening the courses. While at college or technical school the student is not only withdrawn from the world of experience—and that, too, during the most susceptible period of youthful freshness—but is always dominated by teachers; the time is so entirely spent in learning from others that there is no possibility of properly developing either imaginative power or individuality. Therefore, not only is physical power sacrificed, but mental procreative power also—this latter surviving only in the genius; whereas, in reality, if education were of true avail, its one great and chief office should be to call forth and develop whatever spirit of originality, whatever element of genius, may lurk in the mind.

Over-teaching seems to me to be the bane of American schools of every grade, even more than of ours. And there is grave danger, especially in America, that the work of education may be over-organized. Classes are being formed to give special instruction in every section of every subject; in consequence, much time is wasted in doing formally what might be done far more rapidly and effectively informally when occasion requires, under intelligent direction or with the aid of properly written instructions.

It would almost seem that higher education is being given mainly in the interests of those who are to occupy secondary positions. The industrial leaders in America, it is said, are mostly men who have not enjoyed the so-called advantages of a liberal education. They are men with minds unfettered by the traditions which education, as now given, is only too likely to impart, yet trained in the world of experience, possessed of common sense. But there are exceptions which show that training in scientific method may be of advantage: a number of the men now at the head of the metallurgical industries commenced their careers as chemists—not as engineers, be it noted.

The entire system of education, both here and in America, seems to require reconstruction from bottom to top; it would be well, if I may say so, if we could scrap the whole wretched academic show and start afresh, in order that it may be greatly improved in quality and shortened in duration. Two ideals should be kept in view—we should aim at the development of individuality and encourage productivity. If a proper foundation were laid during early years a vast amount of time would be saved later on; if children were taught really to read, if they were thoroughly practised in the rudiments of scientific method, if they were even allowed to remain

> Perplext in faith, but pure in deeds,

there would be little that they could not afterwards accomplish within a reasonable time, because honesty of purpose would prevail among them and they would work with understanding and resist all but necessary guidance. The greater part of the work which is now done—far too late—at college might then be done at school; or, still better, college might be entered with advantage at sixteen. We need to remember that, as Buckle tells us, the acquisition of fresh knowledge is the necessary precursor of every step in social progress, and must itself be preceded by a love of inquiry

and, therefore, by a spirit of doubt. One great reason of failure is that nearly all our teaching is dogmatic. To use Tennyson's words:—

> There lives more faith in honest doubt,
> Believe me, than in half the creeds.

We need to introduce broader and more philosophical conceptions into our educational practise; it is almost impossible to keep pace with the growth of knowledge and absurd to add perpetually to the burden imposed upon the student. Moreover, it is unnecessary. If more attention were paid to teaching principles and their application, less to mere facts, many of the difficulties with which the student's path is now strewn would disappear and he would do effective work; our higher education is unfortunately afflicted with the disease of fact-megalomania; if the meaning of one tenth of the facts we now lay before the student were properly taught, the remaining nine tenths might safely be jettisoned.

As a very large number of American teachers have studied in Germany and the teaching is often based on German models, it is remarkable that the university system should bear so little resemblance to that of Germany. As a rule, far more routine work is done and far less attention is paid to research work than in Germany. At Cornell University, for example, although the course laid down for students of chemistry covers four years, no thesis work is demanded. At the Johns Hopkins University, on the other hand, the graduate student who desires to take the Ph.D. degree follows a course almost precisely similar to the German course; but this comes after a two years' graduate course, which has no equivalent in the German system. Of late years, however, much attention has been given to research work in America; still, it is not yet rated at its proper value and those who are engaged in the work by no means enjoy the esteem they deserve on that account. Professor Richards, of Harvard, for example, a chemist of brilliant originality as well as an extraordinarily exact worker, was not appreciated by his university until after he had been 'called' to Göttingen. Work which has no commercial aim or value is not easily recognized as important. As the spirit of inquiry is the mainspring of progress, its cultivation should be a first charge on the bank of education. Germany has long recognized this to be the case, but neither in the United States nor here does such a conclusion yet meet with acceptance. As the prizes offered by industrial enterprise are most alluring, it is essential that more active measures should be taken to develop the capacity for research, so that a larger supply of competent investigators should be forthcoming. And such men are sorely needed to act as leaders in every grade of education.

Science in the Service of the State.—The most striking illustrations of American organizing ability are to be met with at Washington. So far as I am aware, there is nothing anywhere to compare with the way in which science is being utilized in the service of the state by the U. S. Department of Agriculture, which is located in the capital. The origin and development of this department are sketched in a separate bulletin published in 1898. It was established by an act of congress approved by President Lincoln, May 15, 1862. Up to July 1, 1897, it cost, all told, $26,915,988, or less than $500,000 a year.

The department now comprises the following branches: Office of the secretary, the weather bureau, bureau of animal industry, bureau of plant industry, bureau of forestry, bureau of chemistry, bureau of soils, bureau of statistics, division of entomology, division of biological survey, division of accounts and disbursements, division of publications, office of experimental

stations, office of public road inquiries, library.

Agricultural experiment stations have been established in each state of the union under the Hatch Act of March 2, 1887. Agriculture is also supported by the endowment of agricultural colleges under the Morrill Law of August 30, 1890, out of funds arising from the sale of public lands. A list of the agricultural colleges and experiment stations, together with particulars as to courses of study, etc., is given in a separate bulletin (No. 122) published by the department. The organization of the department in 1903–4, together with a brief statement of the work of each division, is to be found in a special circular (Division of Publications Circular No. 1). Full particulars as to the appropriations for the current year are contained in the act (Public No. 158). A year after its organization its entire force consisted of 29 members, mostly clerks. On July 1, 1902, the staff numbered 3,789, of whom 1,209 were executive officers, clerks and messengers, 2,081 scientific investigators and 499 laborers.*

The Agricultural Department in Washington is not merely an office—it is also a busy hive of research. A large number of laboratories are attached to it, in which investigations are being carried on, bearing, in one way or another, on problems in agriculture. Much research work is also done in the state experiment stations; in the main, however, these serve to bring under the notice of farmers the importance of science to agriculture by demonstrating the value of methods of cultivation, manures, etc. There is no question that the research work done under the auspices of the agricultural department and in the experiment stations is of the very greatest value, and is contributing most materially to the development of agricultural industry. To take only one illustration, whereas, in 1884, the amount of sugar made from sugar beet was only about 300 tons, the beet crop of the past year is estimated to yield 400,000 tons; the amount of sugar made in the United States from the sugar cane being only about 300,000 tons. This extraordinary increase, I believe, is due practically entirely to the influence exercised from Washington. A map showing the regions in which the temperature conditions were favorable to the growth of the sugar beet was first prepared by Dr. Wiley, the head of the bureau of chemistry. Seed was then issued to farmers in various districts, together with directions how it was to be dealt with, and the produce was subsequently examined for sugar; in this way it was determined where the beet could be grown successfully. The advantages to be derived from the cultivation of the crop were also made clear to the farmers. An industry of great importance has in this way been gradually brought into existence; at the same time, farming practise has been vastly improved and land has increased considerably in value owing to its having received proper treatment.

The department is undoubtedly exercising an extraordinary influence on the education of farmers by distributing literature among them and by encouraging and helping them in every possible way; indeed, it is certain that, by one means or another, the American farmer is gradually being led to see that science is indispensable to agriculture.

The work that is being carried on in New York state under the direction of Professor Bailey, the director of the College of Agriculture at Cornell University, Ithaca, may be referred to in further illustration, as

* Since this report was in type I have received summary reports of work done in various bureaus of the department: I owe them to the kindness of their several chiefs. It is impossible now to notice them in this report, but I trust to be able to deal with them specifically elsewhere.

this is now a head center of the nature-study movement. The character of one branch of the work may be best made clear by the reproduction of the following circular letter relating to a reading course for farmers:

To the Editor,

Will you not help us to reach the farming community by inserting the following note? The reading-course described below is provided for the farmer by state appropriation. We want him to receive the fullest possible benefit. Kindly send us a marked copy of the issues containing this notice.—Very truly yours,

S. W. Fletcher,
Supervisor of Farmers' Reading Course.

WINTER EVENINGS ON THE FARM.

The wide-awake farmer is now wondering what he can do in the long winter evenings to aid him in the work of next season. He would like to know more about the things with which he has to do; how he can feed his crops better; how he can make a piece of 'worn out' land fertile once more; how he can get the greatest feeding value from the stock of hay and grain in his barn. Many of these practical questions are in his mind at this time.

We would suggest that one of the best ways of answering them is through the 'Farmers' Reading Course,' conducted by the College of Agriculture of Cornell University. Once each month, from November to March, a short lesson on some practical farm topic is sent to each member. These lessons are written in a plain way, so that any farmer can readily understand. The only expense to the reader is an occasional stamp in reply. Many thousand New York farmers are now enrolled in this reading course. All that is necessary to become a member is to send your name on a postal card to Farmers' Reading Course, Ithaca, N. Y. The state pays for this work, and every one in the state interested in farming has a right to its benefits.

For many years Professor Bailey has been studying the improvement of the grounds of rural schools. Recognizing that the school playgrounds are, as a rule, 'bare, harsh, cheerless, immodest!' he has sought to interest those connected with the schools in making them attractive and has put forward hints for the proper laying out of the grounds. The literature on this subject issued from Cornell is of a most valuable character.

But perhaps the most interesting of the movements going on under Professor Bailey's influence is the formal organization of junior naturalist clubs in schools all over the state. This is under the direction of Mr. John W. Spencer, known as Uncle John, whom I had the privilege and pleasure of meeting. The object of such clubs "is the study of nature to the end that every member thereof shall love the country better and be content to live therein. Each member is expected to tell Uncle John at least once a month by letter or by drawings what he or she has seen or thought on some topic in nature-study suggested by the teacher or by the bureau of nature study." These letters are duly registered and read. On the receipt of the fourth, a badge-pin is sent to be worn as a testimony that the owner is entitled to all the honors due to a young naturalist. At intervals, Uncle John writes a letter to his young friends. These letters are full of charm.

Teachers' leaflets and a 'nature-study monthly' are issued in connection with the enterprise. The number of children enrolled is over 35,000. There can be no doubt that a pioneer work of great importance is being done, on which it will be possible to build in the future. It is not possible now to discuss in any proper way the method of teaching adopted. I desire to say everything in its favor, feeling as I do that the object in view is all important; but I am satisfied that the work lacks depth and that those engaged in it are not yet aware of the extent to which it is possible to introduce exact method into such studies; they need to be more fully acquainted with the practise of scientific method and with the art of discovery. It would be more nearly correct to speak of

the movement as one for the promotion of nature love rather than as nature study. At present it involves far too little real study and concentration of purpose; which is unfortunate, as rural children particularly need training in exactness.

One branch of work initiated in the office of experiment stations at Washington of extreme importance, to which reference should also be made, is that relating to the nutrition of man, which has been carried out in various parts of the states under the supervision of my friend Professor Atwater—a fellow student with me in Germany in years gone by—who initiated the inquiry in 1877. The scope and results of the investigation are described in the report of the director of experiment stations for the year ending June, 1901. Undoubtedly the most important and valuable part of this work has been that done during recent years at the Wesleyan University, Middletown, Conn., where a large respiration chamber has been erected and brought to a remarkable state of perfection by Professors Atwater and Benedict. The installation is a very costly one. It is possible for a man to live within this chamber for days or even weeks and for account to be kept during the whole time, not only of the products of respiration, but also of the amount of heat given out and the oxygen consumed, with a degree of accuracy equal to that with which ordinary analyses are carried out in a laboratory. No better illustration can be given of the amount of thought and care which is now being devoted to investigations of practical importance in the United States. I went specially to Middletown to examine the apparatus and was gratified beyond measure; to see it alone was worth a pilgrimage to America. The investigations which can be carried out with such a chamber are of far-reaching importance and touch very closely on the domain of household economics. It is much to be desired that we, on this side, should be able to do similar work.

The geological survey is also a well-organized department in Washington. The wealth of material at the disposal of American geologists is extraordinary. If opportunity beget supply, we may look to America as the breeding ground of geologists in the future. Besides field work and the attendant office work, the department now carries on scientific research work on geological problems. It has a well-equipped chemical department, at the head of which is Professor Clarke, who a few months ago delivered in Manchester the lecture commemorative of the centenary of Dalton's atomic theory. Much valuable work has been done in this department, which is now quite the seat of authority in mineral analysis, Dr. Hillebrand, the senior member of Professor Clarke's staff, being probably the most accomplished and experienced analyst of the day.

Lastly, it may be mentioned that a bureau of standards has recently been established at Washington to do work on the lines of that done by our standards department, the board of trade and the national physical laboratory, but with a wider outlook than any of these and well provided with funds.

When we consider how uncoordinated our efforts are, how little public appreciation exists of the value of science to the community, it is impossible not to feel envious of what is going on in Washington. It would well repay us to inquire very fully into the causes which have operated to produce a willingness in America to listen to counsel which here passes altogether unheeded. Something must be done to create a public belief in the value of knowledge, which will lead us to coordinate our scattered efforts. So long as our outlook is merely insular the future may appear to afford little promise; but if we consider

the possibilities the empire affords, there is no reason why our outlook should not be as hopeful as that of the United States. The resources at our disposal, the agricultural possibilities within the empire, may well be regarded as boundless; but we need to make ourselves acquainted with them and to take concerted measures to exploit them. To this end, it is all-important to constitute effective central organizations in this country similar to those which exist in the United States.

One other illustration may be given. In New York, on the occasion of our visit to the Museum of Natural History, Professor Bickmore, to whom this magnificent museum owes its origin, favored us with an account of the manner in which material was provided for illustrated free popular lectures delivered at the museum, for the purpose of making the people acquainted with their country and its resources; and he delivered a charming lecture to us in illustration of the work. The lantern slides prepared in the museum are placed on sale, so that they can be used for educational purposes all over the country. The lecture we heard was of a very popular character; it was quite clear, however, that pioneer work of a most useful character was being done. It was impossible not to feel that if the resources of the British Museum were were made known by sound popular lectures and handbooks; if the museum, the ordnance and the geological survey departments and the colonial office were to cooperate with the education department in making known the conditions which prevail throughout our Empire, it would at once be possible to put the teaching of history and geography on a basis of fact and make these subjects eminently attractive. The geological survey exists as a branch of the educational department, but its reports are of technical rather than of educational value; they might well, in part, be so written as to be delightful essays on physical geography suitable for school use, if only a little thought were given to them from this point of view.

It is quite clear that the right spirit is at work in the United States; but the lack of the critical faculty and of depth of purpose, combined with an excessive development of the utilitarian spirit, are serious drawbacks at present and militate against progress in education. Until higher ideals prevail and sober calculation takes the place of a somewhat emotional and superficial consideration of its problems, it will be difficult to introduce reforms. Here our difficulty is to break through academic, conservative traditions and to arouse an interest in education; that in reality it is the most important of all subjects to be seriously considered has never yet been made clear to us either by preacher or by politician—the message awaits delivery and we need more than anything else the man to make it heard.

HENRY E. ARMSTRONG.

SCIENTIFIC BOOKS.

The Metric Fallacy, by FREDERICK A. HALSEY, and *The Metric Failure in the Textile Industry*, by SAMUEL S. DALE. New York, D. Van Nostrand Company. 1904. Pp. 231.

A bill was introduced in congress in 1902 with a view to the general adoption of the metric system of weights and measures in the United States. The committee on coinage, weights and measures secured the views of a number of prominent representatives of different professions, trades and manufacturing interests, the majority of whom favored the bill. A change of such fundamental importance required mature deliberation; and the committee were disposed to allow the fullest opportunity for discussion on the part of opponents as well as advocates. The bill will not be brought to a third reading for some months yet, and congress will not be apt to take any precipitate action.

Mr. Frederick A. Halsey, associate editor of the *American Machinist*, presented a paper to the American Society of Mechanical Engineers in December, 1902, in which his aim was to rebut the arguments of those who had advocated the metric system, and especially to show how great would be the cost of the change to the mechanical industries of the country. Mr. Samuel S. Dale, editor of the *Textile World Record*, published some articles with the same object in view, particularly in relation to textile interests. The final result is the volume now before us.

The two parts of this volume are very different in tone, and it would be unfair to use the same words of criticism for both. Mr. Halsey's mental attitude is fairly indicated by the following extracts from his introductory chapter. He says (p. 12) of the metric system: "Nowhere has the system made material progress in industry except when backed by the policeman's club. * * * With their system of weights and measures as a foundation, the English-speaking peoples have built up the greatest commercial and industrial structure the world has known. They are asked to enter the slough of despond in which metric Europe wallows in order to help metric Europe out. They are asked to destroy the very warp and woof of their own vast industrial fabric in order that they may assist in weaving another of alien origin and with no resulting gain except to aliens. * * * Representative of their historic methods of development, foundation of their industrial life and bond of union between all sections—shall all these be destroyed for this French fad?" (p. 14). "The pro-metric argument is, substantially, an *a priori* argument. The metric advocates adopt the methods of the old philosophers who laboriously sought to prove what ought to be. My method is that of modern science, which interrogates nature in order to learn what is."

The last paragraph just cited is Mr. Halsey's comment after quoting the views of a number of pro-metric advocates, including such representatives of science as Elihu Thomson, Harvey W. Wiley, S. W. Stratton, Simon Newcomb and Lord Kelvin. Each reader can draw appropriate conclusions regarding Mr. Halsey's estimate of facts without any comparison of personal standing. That his attitude is marked by judicial fairness and dignity can scarcely be claimed any more than that such method is 'that of modern science.' The objects of his criticism are men who have already manifested ability at least equal to that of Mr. Halsey in interrogating nature. What he writes about wallowing in a slough of despond and sacrificing our advantages for the benefit of aliens, all for a French fad, might, perhaps, be called political claptrap of the same value as the cries about 'infant industries,' 'pauper labor' and 'sixteen-to-one.' It certainly is not argument. It emphasizes, what is evident on every page of his book, that he is a carping critic, much given to extreme forms of expression. For example, after quoting Dr. Wiley, Professor Newcomb and Dr. Geddes, he criticizes in these words (p. 96): "Was there ever such a case of distorted perspective? Was there ever such a case of rainbow chasing? As an epitome of the reasons for making this great change this pamphlet is pitiful. Are we a nation of dreaming idealists and transcendentalists that we should be swayed by such considerations?" The man who advocates the displacement of the old standards, he says (p. 97), 'deserves to be placed in the pillory and held up to the scorn of men.' Really, this is somewhat disturbing. It might be considered intolerant if its author were not so evidently a victim of what Mark Twain has aptly called 'French calm.' Such expressions make it hard to take seriously what he writes. A wide but very uncertain margin of discount is naturally suggested. The writer who resorts to sarcasm whenever the chance is presented, who confounds railing with argument, who suppresses or belittles everything that tends to controvert what he wishes to advocate, has only himself to blame if he forfeits the confidence of those who consider fairness an essential element in the effort to get at the truth.

The metric controversy may be summed up in a very few words. Certain people wish to give to our weights and measures the same

simplicity that characterizes our system of coinage, and in the remote future to attain international unity of coinage, weights and measures. Certain other people would lose money and otherwise suffer much inconvenience by the change. No good can result from calling the former doctrinaires or denouncing the latter as selfish. We have to consider the practical question, is the game worth the candle? If so, how can the transition be made least burdensome? If not, how can the existing system be improved with least inconvenience? Each of these questions may receive a different answer, and none of them will be fully answered during the twentieth century. The present writer has elsewhere taken part in the discussion and expressed the belief that if the metric system is to be popularly adopted at all by English-speaking nations it must be through some sort of compromise. Of his critics one scientific friend, a physicist (SCIENCE, Vol. XIX., p. 860), prefers to avoid compromise and believes that the American people will soon do what the French and Germans have done. Another, an engineer (p. 767), opposes all change of standards and thinks the proposed compromise 'might be a good one if the English-speaking race were to disappear from the earth.' The newspaper press has manifested similar diversity in views expressed.

The scientific men are probably as devoted to the metric system as the mechanical engineers are to its opposite. In the scientific laboratories no compromise whatever is now, or will be, necessary. The metric system will continue in use as the most convenient for laboratory purposes. But outside of the laboratory there are a good many considerations that can not be ignored. Even if intemperately urged and exaggerated, as they are by Mr. Halsey, they must be candidly recognized by those who advocate metric reform among the people, and allowance has to be made for two very obstinate and omnipresent opponents, conservatism and vested interests.

Mr. Halsey devotes a large part of his book to a presentation of statistical evidence intended to show that in all of the countries where the metric system has been made legal the people have held on to the old units to which they were accustomed. Adoption by statute is not a guarantee of adoption in practise. A century has not been sufficient to cause the abolition of old names and units among the common people in France, whether in city or country, resort to them being usual when no penalty is involved. The same is true in Germany and Switzerland, and in every other country where the metric system is in business transactions either obligatory or permissive. The fact is in no way remarkable. There is no reason to expect within the next century that conservatism will be so diminished that the exclusive use of the metric system will prevail even in France. The progress already made is all that could be reasonably expected. If the system be established by legal statute in America no such law can be enforced until the people generally shall have forgotten old names and values. If old names are retained and values but little changed the task of assimilation is made easier, but reasonably complete assimilation will take several generations. Thus, while our American coinage system is a model of simplicity and convenience, the rural Virginian persists in using the names 'shillings' and 'pence,' utterly superfluous as these may be. Advocates of the metric system deceive themselves if they think that new standards can be established among the masses, by statute or otherwise, within a few years. The initiative can be, and should be, taken by the central government, and in the application of the law all possible consideration should be accorded, particularly at first, to those whose large pecuniary interests are affected. The first result will be, not the abolition of confusion, but the increase of confusion by an addition to the units and standards in use. None of us to-day will live to see anything better than good progress on the part of the general public in getting accustomed to the new standards and losing devotion to the old ones.

That fairly good progress has been made, and will continue to be made, in the use of the metric system for international commerce may be inferred from the following extract,

printed by Mr. Halsey with another object in view. The collector of the port of New York says (p. 74):

I have caused to be taken from the files of this office a number of invoices from Spain, Italy, Holland and Belgium, and find as follows: From Spain, 233 invoices, in 37 of which the weights are expressed as pounds, the remainder being made out according to the metric system; from Italy, 15 invoices, the weights therein expressed in the metric system; from Holland, 55 invoices, in 14 of which the weights are expressed as pounds, 11 of the 14 are expressed as pounds avoirdupois, and the other 3 invoices not stating the kind of pound, the remainder of the invoices being made out according to the metric system; from Belgium, 126 invoices, in 14 of which the weights are expressed in pounds, 31 in feet and inches, 2 in yards, and 1 in gallons; the remainder being made out according to the metric system.

This is very encouraging to those who believe that all great changes must be gradual. One of the anti-metric advocates writes: 'The question of weights deals rather with the future, but linear measures are tied irrevocably to the past.' The metric advocates should accept this statement with the substitution of 'strongly' for 'irrevocably.' If the statement were true as it stands, we should still be measuring lengths in cubits. The inch has not been invariable in the past. It may yet vary enough to become exactly commensurate with the centimeter if the exigencies of trade should make this desirable, but not otherwise. Or, unwelcome as such a proposition may be to the physicists, the meter, which we all admit to be an arbitrary standard, may yet be lengthened enough to become equal to forty inches. In either event readjustment implies inconvenience and opponents will be plentiful.

All fear about destroying the value of a vast body of technical literature founded on the English system is gratuitous. A very considerable body of literature has grown up, founded on the centimeter. Its value will not be destroyed if the millimeter should be lengthened to one twenty-fifth of an inch. Both the technical world and the scientific world have thus far readily adapted their literature to the times, with no regard for the inviolability of past usage. The fact that Newton's 'Principia' is now but little read does not take away its importance as the foundation of modern exact science. We simply adapt it to modern nomenclature and modern improved methods.

Mr. Halsey's book closes with these words, which apparently settle the case of the metric advocates for all time: 'These people may legislate until doomsday; they may make infinite confusion, endless turmoil, limitless sacrifice; but move the English inch?—the Archimedean lever is still unknown.' Dr. Lardner is credited with having proved that the Atlantic could never be crossed by a steam vessel. The rôle of the prophet is often unsafe; as unsafe as the exhibition of rage in print.

Mr. Dale in his discussion of the failure of the metric system to meet the requirements of those engaged in textile industry is in general more dispassionate than Mr. Halsey, but both writers exhibit considerable personal venom. This is intelligible, if it is not excusable, when we consider that each is a special representative of industries in which many millions of dollars are locked up in machinery that would all need to be changed if a law were passed that should impose a penalty upon the use of standards other than metric. Each considers that such coercion is implied in the legislation that has been provisionally discussed in committee at Washington. Mr. Dale, after criticizing some testimony in favor of the metric system that had been given to the committee by the president of a New England cotton mill and the principal of a textile school, says (p. 148): "This is the kind of evidence that was followed by a report bearing all the earmarks of having been dictated from that metric hothouse, the National Bureau of Standards." He calls the metric system a product of the French Revolution, associating it with the excesses of the Reign of Terror. He makes a violent attack on the personal character of the greatest of French mathematicians, whom he calls 'the designer of the metric system,' and who 'exhibited an utter disregard of principle in both private and public life' and 'appropriated the work of others as his own.' It is not uncommon to find men of genius who are deficient in administrative

ability; but even if we should admit that the author of 'The Nebular Hypothesis' was the ingrate, the time server, the fantastic visionary that he is here represented to be, it is hard to see what logical connection this can have with the question of international uniformity of weights and measures in the twentieth century. Mr. Dale seems to think that his cause, that of protection to textile industries, can be helped by such personalities. Of the great mathematician he says: "He was familiar with theories of infinity, but ignorant of the wants, necessities and limitations of textile manufacturing. The co-workers of this man in constructing the metric system differed from him only in degree. They were a party of mathematical prodigies, ignorant of the essentials of textile weights and measures."

The textile industry is undoubtedly important, but not enough so to warrant Mr. Dale's apparent assumption that knowledge of its technicalities is needed by the student of science or the legislator. That these technicalities are abundant and confusing is sufficiently shown in his chapter on 'The Continental Chaos.' This oldest of arts has always had its variable nomenclature, which has been developed without any reference to theoretic consistency or international uniformity. Even if the metric system had never been devised, the chaos could hardly have been much worse than what is here exposed. Attempts in France to dispel this chaos by legislation in behalf of the metric system have been rewarded with little or no success. Conservatism has been too strong and vested interests too great to permit the enforcement of any interfering laws. The statutes were passed, but had no life. Scarcely any better success has been had in Germany or, indeed, anywhere else. English and American textile standards seem to have been adopted away from home more than any others, this progress being entirely an incident of commercial convenience and not through legislation. Mr. Dale thinks that these textile standards will become the standards of the civilized world. Experience thus far certainly seems to indicate that legislation which contravenes custom in technical arts and manufactures is incapable of enforcement. Any attempts to secure change must be wholly unselfish, and directed toward the advantage of future generations rather than of present interests.

On the whole, this book is much to be commended to the attention of metric advocates, despite the unbalanced intolerance of Mr. Halsey and the ungenerous personality manifested by Mr. Dale. After discounting liberally for its bitter partisanship there remains a mass of information that must be taken into account by those who wish improvement in our system of weights and measures. If the metric system, so thoroughly installed in our laboratories, which are all new, is to be adopted in our industries, many of which are old, no proofs of its excellence will be of any practical value in securing the displacement of what gives satisfaction to those who control trade. If it is finally to win universality it will not be by legislation, but by its superiority, demonstrated by a multitude of trials in various fields, each initially on a small scale, and each suggested by the prospect of gain. Hope of general adoption within a few years after the passage of appropriate legislation has to be very limited. This statement does not imply that hope of its final adoption is to be abandoned. Nor must we claim that such adoption will simplify our weights and measures at first; it will merely add to the diversity; an addition to be deliberately made, with the prospect of the final disappearance of all except what experience may prove to be the best standards. Metric advocates believe these to be the metric standards. Before final adoption standards must be subjected to competition like all else, and only considerations of utility will determine the survival of the fittest.

There is no reason for metric advocates to relax their efforts to secure the adoption of the metric system by the government and its use in all government departments. An international system of weights and measures may gradually become established for the benefit of international commerce. Whether it will be adopted in interstate commerce can not now be predicted. Initial legislation should

be very elastic, and every concession should be accorded that may tend to secure to us the essential features of the metric system, even if we discard a good deal that its founders thought desirable for the sake of consistency. There is plenty of time yet to give this subject mature consideration without undertaking the rôle of either the optimist, the pessimist or the prophet.

W. LE CONTE STEVENS.

WASHINGTON AND LEE UNIVERSITY,
July 8, 1904.

The Development and Structure of Vegetation. Studies in the Vegetation of the State [of Nebraska], III. By FREDERIC E. CLEMENTS. Lincoln, Neb., published by the Botanical Seminar of the University of Nebraska. 1904. Pp. 175.

In the present work Professor Clements has had a double purpose, first, to give an account of our present knowledge of the cardinal concepts in the study of vegetation, viewed in the light of their historical development, and second, to give more exact organization and classification to those ideas as well as greater definition to their terminology. He treats the idea of the association in its various phases, and with its diverse bases; of invasion, with its elements, migration, ecesis (or adjustment to the habitat), influence of barriers, endemism, polygenesis, kinds and manner of invasion; of succession in its various phases; of zonation; and of alternation, involving competition. Each section has its bibliography. Many interesting views are presented in the course of the paper, among others the opinion that competition in plants has a purely physical basis, or, in other words, that competing plants influence one another only as physical, and not as physiological, agents. This view, which it must be admitted is the only one justified by facts at present at our command, would make associations and other groups of this nature merely physical mixtures of plants with no organic connection between the members (excluding parasites, etc.); but it is not improbable that further research will show this view to be incorrect. Another feature of the paper is the attempt of the author to give greater definition to the terminology of the subject, to which end he proposes many new terms, all of which have the positive merit that they are etymologically appropriate and consistent. Whether or not these merits will result in their adoption remains to be seen, but Professor Clements's proposals in this as in his earlier works have the great advantage of being first in the field. The author also emphasizes the need for accurate experimental and statistical field study as a basis for further ecological advance, a matter in which ecologists seem now to be in full agreement. Altogether, Professor Clements has given us a valuable and timely contribution to the study of this increasingly attractive subject, and his work is likely to exert no small influence in its development.

W. F. GANONG.

Mineral Tables. For Determination of Minerals by their Physical Properties. By ARTHUR S. EAKLE, Ph.D., Assistant Professor of Mineralogy, University of California. New York, John Wiley and Sons. 8vo. Pp. 72.

The new features in these tables are the prominence given to color as a classifying character and the restriction to the consideration of two hundred (approximately) common species. Lustre is made very subordinate, the divisions are by the 'streak,' color of the fine powder, and the subdivisions by 'color,' color of the mass.

For minerals which crush to a colored powder this affords an easy and generally accurate separation. But the silicates of all colors and many light-colored minerals yield white powders and their distinction by physical characters alone is not easy in average massive specimens, and this division extends over two thirds of the entire book. No resource is made to blowpipe tests, the inference to be drawn from a paragraph in the introduction being that 'blowpipe analysis' should follow as a separate feature of the course. The time allotted to mineralogy in many colleges would hardly permit this, however.

The omission of the rarer species and the limitation of the necessary apparatus to knife, magnet, lens, streak-plate and hardness scale

make the tables valuable for short courses or for field work. A. J. MOSES.

SCIENTIFIC JOURNALS AND ARTICLES.

THE July number (volume 5, number 3) of the *Transactions* of the American Mathematical Society contains the following papers:

E. B. VAN VLECK: 'The convergence of algebraic continued fractions whose coefficients have limiting values.'

W. FINDLAY: 'The Sylow subgroups of the symmetric group.'

E. W. BROWN: 'On the smaller perturbations of the lunar arguments.'

E. V. HUNTINGTON: 'Sets of independent postulates for the algebra of logic.'

H. F. BLICHFELDT: 'On the order of linear homogeneous groups (second paper).'

J. B. SHAW: 'Algebras defined by finite groups.'

O. VEBLEN: 'A system of axioms for geometry.'

THE contents of the *American Journal of Science* for July are as follows:

B. B. BOLTWOOD: 'Ratio of Radium to Uranium in some Minerals.'

F. M. MCCLENAHAN: 'Constitution of Hydrous Thallic Chloride.'

E. H. SELLARDS: 'Study of the Structure of Paleozoic Cockroaches, with Descriptions of New Forms from the Coal Measures.'

W. A. PARKS: 'Remarkable Parasite from the Devonian Rocks of the Hudson Bay Slope.'

C. R. EASTMAN: 'Asterolepid Appendages.'

A. B. PLOWMAN: 'Electrotropism of Roots.'

O. C. LESTER: 'Oxygen Absorption Bands of the Solar Spectrum.'

The Journal of Nervous and Mental Diseases of July, 1904, contains two articles dealing with Multiple Sclerosis, one by Drs. W. G. Spiller and C. D. Camp of Philadelphia containing a report of two cases and some general observations on the nature of the condition, and the other by Dr. Smith Ely Jelliffe, of New York, on the occurrence and etiology of multiple sclerosis, as observed since the opening of the Neurological Department in the Vanderbilt Clinic of New York City. The interesting fact is brought out that this disease is less frequent than in foreign countries. There is also a discussion of Uremic Hemiplegia, by Dr. T. H. Weisenburg, of Philadelphia, in which he gives reports of several cases, and the results of various experiments. The Periscope contains extended abstracts from *The American Journal of Insanity, Revue de Psychiatrie and Nouvelle Iconographie de la Salpêtrière,* as well as miscellany and reviews of the latest psychiatrical and neurological books, published in this country and abroad.

SOCIETIES AND ACADEMIES.

THE AMERICAN CHEMICAL SOCIETY.
NEW YORK SECTION.

AT the last meeting of the season, held June 10, at the Chemists' Club, 108 West 55th Street, the section elected as officers for the ensuing year:

Chairman—Wm. Jay Schieffelin.

Vice-Chairman—F. D. Dodge.

Secretary-Treasurer—F. H. Pough.

Additional Members of Executive Committee—E. H. Miller, M. T. Bogert, Wm. McMurtrie and T. J. Parker.

The following papers were read:

Alloys (Illustrated): WILLIAM CAMPBELL.

This paper gave the results obtained in a continuation of the work reported at the January meeting. The work will appear in full in an early number of the *Journal of the American Chemical Society.*

The Optical Rotation of Some Cyclic Compounds: F. D. DODGE.

Dr. Dodge called attention to the fact that many of the constituents of the volatile oils contain ring-nuclei of three, four, five or six atoms, with varying degrees of saturation. These compounds are most frequently asymmetric; which is shown by the optical activity.

The questions as to how far the observed rotation phenomena are in harmony with the formulæ which have been proposed, and as to whether the van't Hoff hypothesis is universally applicable, were discussed. It is shown that in single ring nuclei, racemism is generally theoretically possible, and often observed. In the cases of some double nuclei (as the camphor group) racemism appears to be impossible owing to the peculiar molecular structure. The exceptional optical properties of *menthone* were discussed, and a possible explanation found in a peculiar isomerism

of the hexamethylene ring. 'Dextro' and 'lævo' menthone are shown to be not true optical isomens. Several other cases of rotation change were noted, and found to be due in general to chemical alteration of the nucleus.

The author emphasized the value of geometric formulæ, and especially a modification of the Kekulé-Baeyer tetrahedral models, and showed that certain plane formulæ, which have been seriously discussed, are impossible of construction by the models, and must be considered as, at least, improbable.

The Determination of Formaldehyde: R. H. WILLIAMS.

The author gave the results of a critical study of four of the more commonly used methods for the determination of formaldehyde. Two of these, the 'iodimetric' and the 'hydrogen peroxide' being oxidation methods, while the other two, the 'potassium cyanide' and Leglers's 'ammonia' methods, are based upon condensation reactions. The oxidation methods were found in all cases to give noticeably higher results than the condensation methods. Test analyses made with the addition of alcohol, aldehydes and acetone indicated that the difference was not due to the influence of other substances present in the formaldehyde solution, but to the reactions on which the methods are based. Paraformaldehyde may be determined as readily as formaldehyde, with any of the four methods mentioned. The formation and properties of the hexamethylene-tetramine, on which the ammonia method depends, will be studied further.

H. C. SHERMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ASYMMETRON LUCAYANUM IN BERMUDA.

BESIDES establishing the fact that *Amphioxus caribæus*—known since 1876 to exist at the Flatts—is found in numerous localities in these islands, the work of the station this year has resulted in the discovery that another representative of this very interesting group of Chordates—*Asymmetron lucayanum*—is also found in these waters. Especial credit for the discovery of this more rare animal is due to Mr. Louis L. Mowbray, a young Bermudian naturalist in the employ of the station.

E. L. MARK,
Director.

BERMUDA BIOLOGICAL STATION,
FLATTS, BERMUDA, July 22, 1904.

THE ASCENT OF WATER IN TREES.

TO THE EDITOR OF SCIENCE: It would not be necessary to notice at all the note on 'The Ascent of Water in Trees,' published in your issue for July 22, were plant physiologists and physicists alone to be considered. A single remark, for the benefit of those who might be misled, will suffice to show the futility of the theory proposed. The structures at the lower end of the conducting tissues are essentially identical with those at the upper end. If at the upper end the 'water ducts are protected from direct atmospheric pressure by their structures,' they are equally shielded from it below.

C. R. BARNES.

THE UNIVERSITY OF CHICAGO.

CONCERNING SPECTACLES.

RATHER an extensive literature exists on the question raised by Dr. C. Barck in his paper on 'The History of Spectacles' (SCIENCE, XX., July 8, 1904, p. 50) as to whether Nero was near-sighted and viewed gladiatorial combats with glasses. The passages in Pliny's 'Natural History' which have furnished food for this discussion occur in xi. 54, and xxxvii. 16; and the best interpretation thereof known to the writer of the present paragraph is found in Dr. August Nies's interesting thesis 'Zur Mineralogie des Plinius,' pp. 18–20 (Mayence, 1884). The claims of other alleged inventors of spectacles besides those mentioned by Dr. Barck are considered more or less fully in Beckmann's 'History of Inventions,' and in J. Fiedler's 'Geschichte der Erfindung der Fernröhre.'

C. R. E.

SPECIAL ARTICLES.

THE FORMATION OF TOXIC PRODUCTS BY VEGETABLE ENZYMES.

No subject in the domain of plant chemistry has aroused more discussion of late than the physiological rôle of the various enzymes.

Concerning the specific action of a few vegetable ferments, such as diastase, invertase and lipase, a fairly clear and definite idea has been formed, but as regards the functions of other enzymes, particularly those of oxidizing and reducing properties, our knowledge is much less precise, and the greatest diversity of opinion prevails.

As an example of the confusion which exists it is only necessary to review what has been written within the past few years regarding *catalase*. The property which extracts from animal and vegetable tissues possess of decomposing hydrogen peroxide was observed by Schoenbein in 1863, but Loew* was the first to ascribe the reaction to a specific enzyme—catalase—to which he attributed both oxidizing and reducing properties. Loew is of the opinion that, in the respiration processes of the living cell, hydrogen peroxide is formed and that this compound would act detrimentally were it not for the fact that it is destroyed immediately by the catalase. A similar view is shared by Pozzi-Escot,† who, however, declares that catalase is a reducing enzyme and has no oxidizing properties. Kastle‡ and Loevenhart, on the other hand, believe that catalase is concerned purely with oxidation phenomena and that Loew's suggestion, that it prevents the accumulation of hydrogen peroxide, is highly improbable. Without desiring to controvert any of the above opinions, I would like to suggest another possible explanation as to the rôle of the oxidizing and reducing enzymes.

In the course of experiments with sugar cane I have frequently observed that cane, which had been sterilized by steaming, suffers a more rapid deterioration through the attack of molds and bacteria than raw cane. This also holds true, but less noticeably, of the juices from steamed and raw cane. Another observation frequently made was that the juice from the upper green portion of a living cane was more resistant towards fermentation than juice from the riper joints lower down. The juice from the top of the cane also underwent a very rapid darkening after pressing, while that from the middle and bottom exhibited this change to a much less degree. The juice from steamed cane undergoes no coloration whatever. The change in color, resulting from the exposure of the juice or tissues of the cane to the air, is much better observed if the stalk be divided lengthwise; the darkening begins almost instantly in the region of the apex or growing point, and is less and less marked towards the bottom of the stalk. Such coloration phenomena are common to the tissues and juices of most plants and, according to Bertrand, are to be explained by the action of an oxidizing enzyme upon bodies of a tannin nature. Such bodies occur in fact in the sugar cane, and microchemic tests show them to be most abundant in the growing parts.

From the association of coloration phenomena with resistance to fermentation, it is natural to conclude that the dark-colored oxidation products produced by enzymes may have a toxic or germicidal action. That germicidal products, of even a very pronounced character, may be formed in cane juice by enzyme action was shown as follows: Samples of raw and sterilized juice from ripe cane were treated respectively with 0.2 per cent. of resorcin, orcin, pyrogallol and hydroquinone, and left exposed to the air. In every instance the sterilized juices began to ferment first; as regards the raw juices, those treated with resorcin and orcin showed the least resistance to fermentation and those treated with pyrogallol and hydroquinone the greatest. The raw juice treated with hydroquinone turned nearly black in color and remained perfectly preserved for many weeks. In this case the toxic agent was no doubt quinone, the presence of which was plainly indicated by the odor. In the oxidation processes which take place, through enzyme action, when the tissues of green plants are cut or bruised, a quinone body may be formed, or, perhaps, an organic peroxide of the asymmetric peracid

* Loew, U. S. Dept. Agr. Report No. 68. 'Catalase, a New Enzyme of General Occurrence.'

† Pozzi-Escot, *American Chemical Journal*, June, 1903, p. 552.

‡ Kastle and Loevenhart, *American Chemical Journal*, June, 1903, p. 583.

type, which latter group Freer* and Novy have demonstrated to be among the strongest germicides known. The formation of such toxic products would be of immense value to plants in protecting them against infection by micro-organisms, when their tissues are injured. Such protection would be most necessary in the regions of intense growth, and there in fact we find the oxidizing effect of the vegetable enzymes to be the greatest. The toxic products formed would undoubtedly have an injurious action upon the plant itself, were this not prevented by the reducing enzymes, which prevent the diffusion of these substances beyond their points of formation and requirement.

The oxidizing enzymes, no doubt, take part in other important physiological processes besides that of promoting the formation of toxic products. The importance of the latter function seems, however, to have been generally overlooked, and I believe it to constitute a phase of enzyme action well worthy of future investigation.

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THE ENDOSPERM ENZYME OF PHŒNIX DACTYLIFERA—PRELIMINARY REPORT.

THE presence of an enzyme in the resting endosperm of the date seed has been demonstrated as follows: After the embryos were excised from a quantity of seeds the endosperms were ground to a coarse powder and this powder digested cold for six hours with distilled water. The aqueous extract thus obtained was made 40 per cent. alcoholic, after which precipitate No. 1 settled. This precipitate was collected over asbestos and washed with alcohol while the filtrate No. 1 was raised to 80 per cent. alcoholic, after which precipitate No. 2 settled. This precipitate No. 2 was collected over asbestos and washed with alcohol. A portion of precipitate No. 1 was digested with 95 per cent. alcohol with constant shaking for fifteen minutes. The extract was filtered and evaporated to dryness over steam. A very slight residue remained which was insoluble in water and probably consisted of very fine asbestos which passed through the filter. This residue insoluble in water would not affect Fehling's solution, as was expected. The remainder of precipitate No. 1 was extracted with water and the extract filtered. The filtrate was made 50 per cent. alcoholic and digested ten days at laboratory temperatures, after which time it was evaporated to dryness over steam, yielding residue No. 1. This residue was digested for several hours with 95 per cent. alcohol, the extract filtered and evaporated to dryness, yielding residue No. 2, which was found to be very soluble in water and to reduce Fehling's solution. Precipitate No. 1, consisting of carbohydrates insoluble in 40 per cent. alcohol and any proteid either insoluble or carried down with the carbohydrates—evidently during the ten days' digestion in 50 per cent. alcohol—developed a reducing sugar soluble in 95 per cent. alcohol. Precipitate No. 2 was extracted with water and the extract filtered. The filtrate thus obtained was measured equally into four flasks. Into each flask 5 c.c. of soluble starch was titrated. Flasks A and B were immediately made 80 per cent. alcoholic. Flasks C and D remained without alcohol. All four flasks were digested at 40° C. for six hours. The solutions were then evaporated to dryness, yielding residues A_1, B_1, C_1, D_1. Each of these residues was then digested for several hours with 95 per cent. alcohol. The extracts were filtered, and after evaporation to dryness the residues A_2, B_2, C_2, D_2 thus obtained were dried for one hour at 110° C., removed to desiccator and weighed with following results. $A_2 = 0.0085$ gms., $B_2 = 0.0090$ gms., $C_2 = 0.0080$ gms. and $D_2 = 0.0085$ gms. All of these residues were soluble in water and reduced Fehling's solution with a total of 0.0030 gms. of CuO. Whether this reducing sugar developed from the soluble starch or from the carbohydrates present in precipitate No. 2 is unknown. Evidently the activity of the enzyme contained in precipitate No. 2 is not inhibited by 80 per cent. alcohol.

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* Freer and Novy, *American Chemical Journal*, 27, 161–192.

QUOTATIONS.

THE GERMAN YELLOW-FEVER EXPEDITION.

WE recently referred in our news columns to the fact that not long ago the Institute for Ship and Tropical Diseases in Hamburg sent a fully equipped expedition to South America to study yellow fever in particular. The results already obtained by American, English and French observers will now be subjected to thorough tests, and further reports from the expedition will be awaited with much interest. We see in expeditions of this kind the strongest evidence of the great interest now felt in tropical diseases and hygiene. This movement seems to date back only a few years. The epochal discoveries of Patrick Manson and Ronald Ross were followed by the establishment in Liverpool of a school for tropical medicine by means of funds contributed by wide-awake and philanthropic business men. This school has sent out several investigative expeditions, the results of which have been important in the fight against malaria, and more recently in clearing up the etiology of sleeping sickness. In addition, this school gives courses in tropical medicine. Other seaports have followed the example of Liverpool, and similar institutions have been started in London, Hamburg, Bordeaux and elsewhere for teaching and research, location in seaport towns being necessary in order to gain access to the proper clinical material. The German expedition, which also is to study and report on sanitary conditions in South American harbors, is supported financially by the merchants of Hamburg. Whether viewed from the philanthropic or commercial point of view, the study of tropical diseases and maritime sanitation is so important that we can only rejoice because it is fast becoming a matter of international competition. It may not be out of order to ask what is being done in this field in the great seaports of the United States, in addition to guarding against the importation of infectious diseases. So far as we know there is now no place in America where a physician may receive special instruction of the proper kind in tropical diseases and allied subjects. We look for the establishment of an institution of this kind in Manila before long, but it is quite evident that there is room and need for one or more such institutes in the United States proper.—*Journal of the American Medical Association.*

CURRENT NOTES ON METEOROLOGY.

MONTHLY WEATHER REVIEW.

The Monthly Weather Review for March, 1904 (dated May 23), contains the following, among other articles: Professor R. F. Stupart, of the Canadian Meteorological Service, writes on the 'Origin of American Cold Waves,' stating his belief that cold waves may originate almost anywhere over the more northern portions of the continent, and also expressing a doubt in regard to the cold being due entirely to radiation. Rev. Chas. H. Lee, of Racine, Wis., reports that in winter clouds may often be observed gathering on the eastern horizon over Lake Michigan, and moving landward. These clouds are usually seen about noon, after a clear, cold morning, with a temperature of about 0° F. At first the surface of the lake steams 'like a boiling kettle.' Later the steaming ceases, and clouds break off and slowly float shoreward from a great mass of accumulated vapor over the lake to the east. A paper on 'Precipitation for Twenty-nine Years at Dodge City, Kansas,' by E. D. Emigh, leads to the conclusion that there is no foundation for the assertion that the rainfall in western Kansas is increasing from year to year. Rev. Marc Dechevrens, of the Observatory of St. Louis, Island of Jersey, contributes a description of the observations made by him on 'The Vertical Component of the Wind' on the island of Jersey, by means of the Dechevrens universal anemometer. To this article are appended notes by Professors Abbe and Marvin. H. H. Clayton, of the Blue Hill Observatory, contributes 'A Study of Some Errors of Kite Meteorographs and Observations on Mountains,' this being the result of the careful kite work done at Blue Hill since 1894. 'The Winter of 1903–04,' which was characterized by unusual cold east of the Mississippi River, is discussed by W. B. Stockman. The editor of the *Review* considers 'Uniformity in Meth-

ods and Standards of Instruction in Meteorology,' 'Weather Forecasts by Local Observers,' 'Polarization of the Light of the Sky' and other matters.

OCEAN METEOROLOGY.

CAPTAIN D. WILSON-BARKER, in his presidential address before the Royal Meteorological Society (*Quart. Journ. Roy. Met. Soc.*, XXX., April, 1904), believes that the solution of many meteorological problems should be sought in a closer study of the atmospheric conditions over the oceans. The work of Maury and Fitz Roy is appreciatively referred to, and the present state of our knowledge of marine meteorology is sketched. The author says: "In taking note of the meteorological work accomplished in different countries, we find the United States of America well to the fore. . . . The United States government is indefatigable in collecting knowledge beneficial to seamen." The opinion is expressed that we have reached the limits to which it is possible for us to go in weather forecasting with the meteorological knowledge at present within our reach. What is now required is a 'liberal infusion of scientific imagination into our midst.' There is appended to this paper a list of some of the publications bearing on marine meteorology issued between 1886 and 1903, and the illustrations comprise a series of charts of temperature, pressure, winds, rainfall and cloudiness over the oceans.

WHEAT IN CANADA.

IN the *Canadian Magazine* for April, Dr. Wm. Saunders, in discussing wheat-growing in Canada, states that he has received from Dunvegan, on the Peace River, 414 miles north of Winnipeg, samples of wheat weighing 64 pounds to the bushel, and from Fort Simpson, 818 miles north of Winnipeg, Ladoga wheat weighing 62½ pounds to the bushel has been obtained. Between sowing and harvesting the time varied between 101 and 108 days. The quick ripening of cereals in far northern latitudes is well known, and the successful cultivation of wheat in northern Canada means that the agricultural future of those northern territories is much brighter than was at one time supposed.

INTERNATIONAL CLOUD ATLAS.

A NEW edition of the 'International Cloud Atlas,' published in 1896 under the direction of de Bort, Hildebrandsson and Riggenbach, is to be undertaken, provided sufficient interest is shown in the matter by scientific men. The 'Atlas,' as is well known to readers of SCIENCE, presents views of cloud forms classified in accordance with the so-called international classification of clouds, which was officially adopted and recommended by the International Cloud Committee in 1891. The illustrations are beautifully colored, and quite apart from its great value to meteorology, the 'Cloud Atlas' is well worth owning for the beauty of the illustrations alone. It is to be hoped that all those who have found the atlas useful in their work will communicate with the committee in charge of the publication of the new edition.

BRITISH METEOROLOGICAL COUNCIL.

THE committee appointed by the British treasury in December, 1902, 'to inquire and report as to the administration by the meteorological council of the existing parliamentary grant, and as to whether any changes in its apportionment are desirable in the interest of meteorological science, and to make any further recommendations which may occur to them, with a view to increasing the utility of the grant,' has made its recommendations. These include the reconstitution of the meteorological office as a department under the control of the board of agriculture and fisheries; the appointment of 'a man of science as a director of meteorology, appointed after consultation with the Royal Society'; the appointment of an advisory board of five members, two being nominated by the Royal Society, one being the hydrographer to the Admiralty, one being a representative of the Board of Trade, and one of the Board of Agriculture and Fisheries; and the appointment of a second officer as scientific assistant to the director. The other recommendations relate

to the transmission of daily weather reports by telegraph; the use of wireless telegraphy 'in providing advance news of weather on the Atlantic'; an increase of the office staff, and the provision of new quarters for the central office.

ANTARCTIC WINDS.

Dr. Erich von Drygalski, in a paper read before the Royal Geographical Society on April 25 last, on the German South Polar Expedition, calls special attention to the winds noted during the *Gauss* voyage to the far south. The zone of prevailing westerlies was left behind and a trough of low pressure was crossed, the ship remaining on the southern slope of this trough, where the pressure rises again to a maximum over the continent. Here the winds were found to be prevailingly easterly, 'which sweep down from the south over the vast uniform and but slightly inclined surfaces of the inland ice, and appear on the sea-board as easterly, foehn-like gales.' These gales, according to Dr. von Drygalski, give this south polar region its distinctive character, and also its limits, and by their frequency and uniformity 'they reveal the immensity and the homogeneous nature of those Antarctic lands.'

NOTES.

A. B. MacDowall (*Met. Zeitschr.*, XXI., 1904, 77–78) believes that during the last sixty years sunspot maxima have been accompanied in England by higher temperatures. He thus takes a view directly opposed to that of Köppen and Nordmann, who believe that the temperatures are higher (in the tropics) during sunspot minima. MacDowall also publishes curves of pressure at Ben Nevis Observatory and of the moon's phases, in which he considers the coincidence sufficiently marked to lead to a belief of cause and effect, and curves of relative humidity at Greenwich and of the moon's phases, which seem to him similarly related.

The Deutsche Seewarte (Hamburg) has begun the publication of a pilot chart, to be issued quarterly, of the North and Baltic Seas. The same institution has also lately begun to issue charts showing for 8 A.M. each day the distribution of pressure over the North Atlantic between Europe and North America, and also the force and direction of the wind. These charts are published as soon as possible after date.

Sir John Eliot, lately at the head of the Indian Meteorological Department, gives it as his opinion, as quoted in *Nature*, Vol. 69, 538, that 'the next development of weather study will almost certainly be in the direction of international or world meteorology, and its relation to the phenomena of sunspots and terrestrial magnetism.'

Two recent studies on the vertical distribution of temperature in the free air are the following: R. Assmann, 'The Temperature of the Air above Berlin,' translated in *Monthly Weather Review*, XXXII., 1904, 177–180; L. T. de Bort, 'Décroissance de la Température avec la Hauteur dans la Région de Paris,' *Ciel et Terre*, XXIV., 1904, 579–583.

The Prussian Meteorological Institute has issued a new (second) revised edition of its 'Anleitung zur Anstellung und Berechnung meteorologischer Beobachtungen.' The first part deals with observations at second and third order stations.

R. DeC. Ward.

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STOMACH STONES AND FOOD OF PLESIOSAURS.

In a recent paper* on North American Plesiosaurs, Dr. S. W. Williston, in discussing the probable significance of the pebbles so often found associated with plesiosaur remains, says: "What the use of these pebbles was I will not venture to say. They may have served as a sort of weight to regulate the specific gravity of the animals or they may have been swallowed accidentally. If, as I believe probable, the plesiosaurs were in the habit of feeding upon invertebrate animals, seeking such in the shallow muddy bottoms, the pebbles may have been taken with the food unintentionally. I doubt this, however. I may add that all specimens do not reveal similar pebbles."

* Field Columbian Museum Publication number 73, page 75.

During the summer of 1903 the writer collected fossils in the Niobrara shales in South Dakota, finding the remains of many plesiosaurs. In nearly every instance a large number of siliceous stones were found associated with the bones, often embedded in the matrix en masse. In one specimen in which the largest dorsal vertebræ were four inches in diameter, there was at least half a bushel of these stomach stones, ranging from the size of a walnut to four inches across.

Considering the weight of these stones, the wonder is that so many specimens contain them. One would expect that when the flesh began to decompose, the weight of these stones would be too great to be contained by the weakened tissues and that they would be lost before the animal reached its final resting place. This may well explain the absence of stones in some cases.

Throughout the Niobrara formation in Dakota baculites are very abundant while scaphites are rare, especially in the shales. I could not be certain that any of the baculites associated with the plesiosaur remains had been eaten by these animals but in plesiosaur specimen number 5803 of the American Museum collection I found a variety of fossils representing this animal's last meal. Great numbers of fish vertebræ were scattered among the bones, while there were several pterodactyl bones, broken in small sections. But of chief interest were seven scaphites, more or less broken, which had without question been eaten by this animal. One other specimen had scaphites associated with it. The conclusion seems evident that invertebrate animals formed a large part of the food of plesiosaurs and that, in default of crushing teeth, the breaking up of the food was effected by the aid of these stomach stones, the presence of which further implies a thick-walled, gizzard-like arrangement in the alimentary canal.

BARNUM BROWN.

THE ALPINE LABORATORY OF THE BOTANICAL SEMINAR OF THE UNIVERSITY OF NEBRASKA.

THE striking diversity of conditions and of vegetation in high mountain ranges makes them ideal places for field experiment. Their value is greatly increased, moreover, when their slopes arise directly from the plain, as in frontal ranges. This is the case at Pikes Peak in the Rampart range of the Rocky Mountains, where the distance from the plains at an altitude of 1,800 meters to the alpine summit at 4,200 meters is less than ten miles. The significance of this is evident when one reflects that these ten miles contain in miniature the habitats and formations found between latitude 40° and the arctic circle: in less than a half-day, one may pass from the temperate zone through the boreal-subalpine to the arctic-alpine zone. The opportunity for the study of the development and structure of vegetation is unique. The major zones are in evidence as nowhere else, and their ecotones are clear-cut. Weathering and erosion are at a maximum, making new habitats and destroying old ones, and the developmental history of formations may be read from hundreds of stages. Experimental methods in vegetation and in the evolution of new forms may be applied with an ease and a certainty of freedom from accidents and interference which can be obtained only with difficulty in other regions. The dream of the physiologist (ecologist) to have his laboratory out-of-doors may be realized here, and it is merely a matter of time until methods will be found by which research will deal primarily with the experiments of nature, and the walled laboratory will be relegated to a purely secondary place.

The reconnoissance work done by different members of the botanical seminar of the University of Nebraska in various parts of the Rocky Mountains from 1893 to 1898 showed that the Pikes Peak region possesses the combined advantages of accessibility and diversity to a degree found nowhere else. This country was worked over more in detail in the summer of 1899, and Minnehaha, at an altitude of 2,500 m. on the Cog railway, was selected as a base. Minnehaha is within an hour's walk of the plains, and an easy climb of two hours brings one to timber line on Mount Baldy. It is in the midst of the coniferous and aspen forests of the subalpine zone, in a locality

peculiarly rich in talus and burn successions. Within a radius of five miles are found more than twenty distinct plant formations. In 1903, stations were established at Manitou at 1,900 m., and on the top of Mount Garfield at 3,800 m., and automatic records were obtained throughout the growing season for the three zones, foothill, subalpine and alpine. During the present season, these stations are to be equipped with thermographs, psychrographs and automatic photometers, while water-content determinations will be made at stated intervals. A small cabin has been acquired at Minnehaha, and it is intended to convert this into a laboratory ultimately. It is the purpose of the alpine laboratory to carry on investigations under field conditions alone, and the building will be equipped only with such books, microscopes and other instruments as are necessary to field experiment.

The general phytogeographical survey of the Colorado mountains, which was begun in 1896, has been carried out along new lines in vegetational research, and is now nearly completed. The structural characteristics of the mountain formations have already been indicated in a series of formation herbaria, entitled 'Herbaria Formationum Coloradensium,' issued in 1902, while the methods of research employed have just been published in a paper, 'The Development and Structure of Vegetation.' A large number of permanent and denuded quadrats have been established for the experimental study of invasion and competition, and considerable work in experimental ecology has been initiated by changing habitats and transferring species to diverse habitats. Special problems in succession and adaptation are under investigation by advanced students, and the results will appear during the coming year.

The facilities of the laboratory are at the disposal of botanists and students desiring to do advanced work or to carry on investigation, upon the payment of a nominal fee. Good accommodations may be secured at reasonable rates in the mountain hotels at Minnehaha and Halfway. Minnehaha is reached from Manitou by the trains of the Cog railway, over which commutation tickets may be obtained at reduced rates. Detailed information will be furnished upon application to Dr. Frederic E. Clements, The University of Nebraska, Lincoln, Nebraska.

THE CULTIVATION OF COTTON IN THE WEST INDIES.

It is satisfactory to report that the experimental cultivation of cotton in the West Indies has proved a success, and that the industry is now established on a commercial basis. Plantations exist in Barbados, St. Lucia, St. Vincent, Montserrat, Antigua, St. Kitts, Trinidad, and the smaller islands, while plots have also been started in Jamaica and British Guiana. The total area estimated to be under cultivation is 4,000 acres. During the season just ended Barbados alone shipped, up to March 31, 244 bales and two bags of cotton, weighing 61,000lb., and the gins have been busy since. The Imperial Department of Agriculture, which has the work in hand, has orders from planters for Sea Island seed sufficient to plant 7,000 acres, and as this quantity has been paid for the presumption is that it will be used. In Jamaica, where the pioneer work is being carried out by the Board of Agriculture, enough seed has been disposed of to plant 500 acres. A number of Syrians, who are acquainted with cotton-growing in Egypt, are engaged in the cultivation there. Central factories for ginning and pressing the cotton have been erected in the various islands, and a cotton gin expert from the Sea Islands has just completed four months' work on the machines, all of which are now in perfect working order. He states that the factory in St. Vincent is the best-arranged and best equipped he has ever seen. A nine-hours' run of the six gins yielded 3,800lb. of lint; in Barbados, where the methods and appliances are not so scientifically complete, a similar run gave from 1,500lb. to 1,600lb. There are a few private ginneries, but the majority are government undertakings carried on under the direction of the Imperial Department of Agriculture. The cotton is ginned, baled and shipped for the planters for 3c. per lb. of lint; seed cotton is also purchased at the rate of 4c. per lb., which is

equivalent to payment at the rate of about 11d. per lb. for the lint in the Liverpool market. The prices obtained for the Sea Island cotton have been highly satisfactory. One recent consignment from Barbados was valued at from 16d. to 17d. per lb., another averaged just under 15d., the highest price being 16½d., and the lowest 13d. Prices current exhibited in Barbados at the same time showed that Sea Island cotton was being quoted in Savannah at from 10d. to 12½d., but this was evidently the price for common lint, as the last crop on the Sea Islands brought from 30c. to 35c.—this, of course, representing the result of 30 odd years of careful selection and cultivation. The figures given are sufficient to indicate that West Indian cotton, grown from Sea Island seed, is capable of yielding a return quite equal to the finest product of America. It is calculated that, the yield of lint being assumed to be 204lb. per acre—the average in America—and the total cost of placing it in the Liverpool market 7d. per lb. for cotton fetching 12d. per lb., the net profit would be at the rate of £5 2s. per acre. Labor is cheaper in the West Indies than in the Southern States; the cotton gin expert referred to was amazed at the low value of the labor in Barbados.

Sir Daniel Morris, the head of the Imperial Department of Agriculture, is of opinion that the only cotton that should be grown in the West Indies is the Sea Island variety, which, it is well known, is a native of these islands. Other varieties are therefore being eliminated. Some planters favor the Upland, and even the indigenous varieties which are still found growing wild, but it will undoubtedly prove more advantageous to devote attention only to the highly cultivated long-staple Sea Island cotton. The area throughout the world suitable for the growth of Upland is unlimited; that able to produce Sea Island is strictly limited. The latter fetches double the price of any other cotton, and like Blue Mountain coffee, will remain unaffected by future fluctuations of the market. A sample of the native cotton of Jamaica has been sent to England and pronounced very fine, being valued at 14d. per lb. It is a cotton which appears to resist insect pests, and many think that a first-class variety might be evolved from it. The experiments in the island, however, are being made with Sea Island seed, and it will probably be found wiser to begin where the Sea Island planters have left off than to engage in experiments which may not prove successful.

Many difficulties have naturally been encountered in establishing the industry, owing largely to the inexperience and ignorance of the growers, the most formidable being the attack of the cotton worm. Remedies were not at hand, and loss was sustained, but the planters are now forearmed, and they believe themselves able to cope with any similar emergency. Every assistance is rendered to growers by the Imperial Agricultural Department, which has published and circulated an extensive literature on the subject. One of Sir Daniel Morris's latest ideas is to send the officers of the department to the various islands to deliver popular lectures on the industry with magic-lantern illustrations. He recommends, however, that only capable planters should go in for cotton-growing at present, and advises those who wish to come out to the West Indies to embark on planting on a large scale, to pay a visit first to St. Vincent, and study the conditions and opportunities there. Great credit is due to him for his indefatigable efforts to promote the industry during the past four years. West Indian planters are not very ready to strike out on new lines, and, but for the steady persistence and influence of the department, aided by practical assistance from the British Cotton Growers' Association and West Indian Committee, it is doubtful whether the present important results would have been achieved.

DECENNIAL PUBLICATIONS OF THE UNIVERSITY OF CHICAGO.

MOST of the eighteen volumes originally planned as decennial publications of the University of Chicago have been issued. The University Press announces the following as among the volumes that may be expected shortly:

Lectures on the Calculus of Variations. By OSKAR BOLZA.

This treatise is, in substance, a reproduction in considerably extended form of a series of lectures delivered by the author at the Colloquium held in connection with the summer meeting of the American Mathematical Society at Ithaca, N. Y., in August, 1901. It gives a detailed account of the typical and most important class of problems in the calculus of variations—in which an integral depending upon a plane curve and containing no higher but the first derivatives of the unknown functions is to be maximized or minimized—with special emphasis upon the progress of the theory during the last twenty-five years. The following topics are treated: (1) The older theory of the first and second variation from Euler to Jacobi, and the critical revision of its foundations and demonstrations by DuBois-Reymond, Scheeffer, Weierstrass and others. (2) Weierstrass's theory: the problem in parameter-representation, the fourth necessary condition; sufficient conditions. (3) Simplifications and extensions of Weierstrass's theory (especially by Kneser and Hilbert. (4) The so-called isoperimetric problems. (5) Hilbert's existence theorems.

The Study of Stellar Evolution: A Popular Account of Modern Methods of Astrophysical Research. By George Ellery Hale.

The purpose of this book is to tell how the origin, development, and decay of celestial bodies are studied in a modern observatory. The remarkable advances in astronomy during the second half of the nineteenth century, including the development of great telescopes, the introduction of the spectroscope, the many discoveries made with its aid and the results obtained through the use of photography, have given the study of stellar evolution a prominent place in the work of many observatories. The explanations of instruments and methods are accompanied by illustrations, and the most recent astronomical photographs obtained with the telescopes of the Yerkes Observatory are reproduced in a series of plates.

Glacial Studies in Greenland. By Thomas Chrowder Chamberlin.

This book will consist of a detailed description of about fifteen Greenland ice tongues, and of a portion of the main ice cap, dwelling especially upon the significant features, followed by a chapter on generalizations, a chapter on experiments, a chapter on theoretical deductions and a chapter on the applicability of the generalizations and deductions to the great ice invasions of the past.

Studies in General Physiology. In two Parts. By Jacques Loeb.

This work will contain some of the author's principal papers on the subjects of animal tropisms, heteromorphosis and artificial transformation of organs, artificial parthenogenesis, physiological effects of ions, the effects of lack of oxygen, function of cell nucleus, etc. These papers have appeared in scattered German periodicals or as separate publications in German, and many of them are now out of print or inaccessible.

DR. J. C. McCONNELL.

In the death of Dr. J. C. McConnell, anatomist of the Army Medical Museum, which occurred on July 25 at Liberty, N. Y., where he had gone for recuperation, more than one science has lost an efficient coadjutor. Apart from the profession of medicine and anatomy and their application to the duties of his office, Dr. McConnell utilized his leisure as a delineator of objects of natural history, especially shells and fossils, crania and bones. He had for nearly thirty-five years carried on this work, and it is certain that as a draughtsman in black and white line, for scientific purposes, he had no equal in this country, if in the world.

About his last important work was the completion of the drawings for the illustration of the still unpublished Miocene volume of the Maryland Geological Survey. Many thousand exquisite drawings had been prepared by him for the National Museum and various surveys, as well as the Army Medical Museum, in the course of his career. To those requiring such service his loss is nothing short of a calamity. In his personal relations Dr. McConnell was attractive and genial. His official associates as well as those who knew him chiefly as an artist, will sympathetically join in the regrets of his bereaved family.

SCIENTIFIC NOTES AND NEWS.

DR. C. H. TITTMANN, chief of the Coast and Geodetic Survey, has left Washington for Alaska, where he will meet Dr. W. P. King, chief astronomer of Canada, in order to mark the boundary line between Alaska and Canada in accordance with the decisions of the commission that met last year in London.

MR. BAILEY WILLIS, of the U. S. Geological Survey, has returned from China, where he has been making geological explorations under the auspices of the Carnegie Institution.

PROFESSOR CHARLES E. BESSEY, of the University of Nebraska, is visiting the Minnesota Seaside Laboratory at Vancouver Island.

PROFESSOR H. H. RUSBY, of the New York College of Pharmacy, is at the Kew Botanical Gardens studying the herbaria from South America.

DR. T. HOMÉN, professor of physics at the University of Helsingfors, and three other professors of the university have been deported to Russia as a consequence of the assassination of General Bobrikoff. It is taken for granted that these professors had no connection with this crime, but in any case the conditions must be regarded as unfortunate.

THE senate of Heidelberg University proposes to establish a gold medal in honor of Professor Kuno Fischer to be conferred once in five years for work on the history of philosophy in Germany.

THE Paris Academy of Sciences has decided to award its LeCompte prize of the value of $10,000 to M. Blondlot for his researches on the so-called n-rays.

AT the celebration of the foundation of the University of Giessen on July 1, the rector, Dr. R. Brauns, made an address on the development of geology and mineralogy at the university since the year 1850.

A MEDALLION in memory of the late Sir George Gabriel Stokes, which has been erected in the north aisle of the choir of Westminster Abbey, was unveiled on July 7 by the Duke of Devonshire, chancellor of the University of Cambridge, and formally transferred to the authorities of the Abbey. Addresses were made by Sir William Huggins, Lord Rayleigh and Lord Kelvin.

THE monument erected to the memory of Pasteur in the Place de Breteuil, Paris, was unveiled on July 16 by President Loubet. In addition to Mme. Pasteur, there were present numerous officers of the government, members of the diplomatic corps and men of science.

WE learn from the *Journal of the American Medical Association* that Professor Czerny has endowed a prize in honor of his deceased father-in-law, the famous clinician, Adolf Kussmaul. The sum of $2,500 has been paid for the purpose to the Heidelberg University, and the income will be awarded every third year, on Kussmaul's birthday, February 22, for the best therapeutic achievement during the preceding three years, published first in German literature.

A PORTRAIT-BUST of Dr. Otto Kahler, formerly professor of medicine at Vienna, has been unveiled in the arcades of the school of medicine.

A PUBLIC meeting has been held at Bury, England, to celebrate the bi-centenary of the birth of John Kay, of Bury, inventor of the fly-shuttle, to promote a public fund for the erection of a statue in memory of the inventor and to institute scholarships.

MRS. MARY B. COULSTON, recently appointed assistant in agriculture in the University of California, died on July 17.

SIR JOHN SIMON, K.C.B., former vice-president of the Royal Society and president of the Royal College of Surgeons, well known for his important services on behalf of the public health, died on July 23, at the age of eighty-eight years.

MR. ALFRED H. ALLEN, the author of a well-known work in eight volumes on commercial organic analysis and of many papers on applied chemistry, died at Sheffield on July 14, at the age of sixty years.

DR. RUDOLPH AMANDUS PHILIPPI, for many years director of the Natural History Museum at Santiago, Chili, and the author of many contributions to zoology and botany, has died at the age of ninety-six years.

WE regret also to record the death of Dr. Gustav Hempel, professor of agriculture at

Vienna, and of Dr. Otto Christian Lovén, formerly professor of physiology at Stockholm.

M. ALFRED PICARD has been appointed commissioner of France at the St. Louis Exposition.

THE American Mathematical Society will hold its eleventh summer meeting at St. Louis on September 16 and 17. The headquarters will be at the Inside Inn on the Exposition grounds. Professors H. S. White, A. S. Chessin and E. R. Hedrick are the committee in charge.

THE French Association for the Advancement of Science meets at Grenoble from the fourth to the eleventh of August; the Swiss Association met at Wintherthour from July thirtieth to August the second.

THE International Botanical Congress will meet in Vienna next year from June twelfth to eighteenth.

THE trustees of the Percy Sladen Fund for the assistance of scientific research, the establishment of which with an endowment of $100,000 we recently noticed, have held their first meeting, and will meet again in November to consider applications for grants.

ACCORDING to *Nature* the report of the committee on ancient earthworks and fortified enclosures was presented to the congress of archeological societies on July 6. The committee expresses regret that more archeological societies have not taken up the idea of compiling a schedule of the ancient defensive works in their respective districts; and it is urged upon the secretaries of societies to arrange, when possible, for the survey and scheduling of all such works as are included in the inquiry. The committee concludes the report by again impressing upon archeologists the importance of doing their utmost to prevent the destruction which from time to time threatens so many defensive enclosures of earth or stone.

The Journal of the American Medical Association states that the first subject for its prize essay is announced by the medical faculty of the University of Munich as follows: "It has been stated that mice can not be adequately nourished with pure food stuffs (albumin, fats, carbohydrates, mineral salts and water). Other investigators, on the other hand, have succeeded in accomplishing this. The faculty offers a prize for research in this line on pigeons, which can readily be fed on mixtures of the pure food stuffs." The subject announced for this year is given out again for further study for next year's competition: 'Study of the structure of the germinal vesicle in a large vertebrate.'

THE *Scotia*, bearing the Scottish Antarctic Expedition, under the leadership of Mr. Bruce, has returned to Glasgow, bringing, it is said, valuable collections.

REPORTS have been received from Dr. Max Uhle, who, since the beginning of the year, has renewed his archeological explorations on the coast of Peru, carried on by him through the liberality of Mrs. Phoebe A. Hearst for the department of anthropology of the University of California. Dr. Uhle made new excavations at Ancon, in several parts of the so-called necropolis, with a view to determining the relative ages of the cultures represented by the different kinds of mummies and objects. After abundant material for this purpose had been obtained, excavations were made a short distance south of Ancon. Here, in a hitherto unsuspected deposit free from mummies, remains of an early culture distinct in character from any other in Peru were found. After completing his investigations at this spot, Dr. Uhle proceeded northward along the coast toward Supe or beyond.

WE learn from the London *Times* that at the one hundred and fiftieth annual meeting of the Society of Arts held recently, the business consisted in the election of the new council and the reading of the report. The Prince of Wales was elected president for the third year in succession. The report stated that the society's Albert Medal had been awarded to Mr. Walter Crane in recognition of his services in the promotion of decorative art. The prizes given during the year included the Swiney Cup for a work on jurisprudence, the Owen Jones, Mulready, and North-London Exhibition Trust prizes for work by art students, and prizes for fire pre-

vention apparatus awarded at the International Fire Exhibition last year, while the Benjamin Shaw Trust prize is now under offer for a respirator for use in dangerous trades. The numbers of candidates at the examinations showed a large increase last year. The report concluded with some references to members of the society who had died during the past year, among the most memorable of whom were Sir Frederick Bramwell and Sir Henry Stanley.

'THE Economic Resources of the Northern Black Hills' is the title of an elaborate report recently published as Professional Paper No. 26 by the United States Geological Survey. The chief author of the paper is Dr. J. D. Irving, but chapters have been written by Mr. S. F. Emmons and Dr. T. A. Jaggar, Jr. The report is in two parts, the first part, on the general geology of the Northern Black Hills, being the work of Dr. Jaggar, and the second, on the mining geology of the region, that of Messrs. Irving and Emmons. The entire report fills 214 pages and includes over 40 illustrations. The area covered is comprised mainly within the Spearfish and Sturgis quadrangles, which were surveyed geologically in the summers of 1898 and 1899 under the direction of Mr. S. F. Emmons. These quadrangles include the major portion of the mineralized and productive territory, but as a few ore bodies that fall without its limits have been described the title has been expanded to cover the mining region of the northern Black Hills. Dr. Jaggar's treatment of the general geology of the district includes a discussion of its general structure, topography, drainage and stratigraphy. The intrusive porphyries are described in detail and the history of their intrusion is given. A description of the Algonkian, Cambrian, Ordovician, Carboniferous, Tertiary, and Quaternary formations of the district closes the first part of the report. In the second part of the report, which treats of the mining geology of the district, theoretical discussions are either excluded or made as brief as possible. The work is chiefly descriptive in character. The first four chapters describe (1) the ore deposits in Algonkian rocks, (2) those in Cambrian rocks, (3) those in Carboniferous rocks, and (4) those in rocks of recent origin. A fifth chapter is devoted to detailed descriptions of particular mines in the district.

SIR THOMAS ELLIOTT, for the British Board of Agriculture, has sent the following reply to the Association of Chambers of Commerce, who urged the importance of establishing a national school of forestry: "The president of the Board of Agriculture and Fisheries fully recognizes the importance which attaches to the question of afforestation and to the provision of a national system of instruction in forestry. Steps have already been taken in more than one direction to give effect to the recommendations of the departmental committee which was appointed in 1902, under the chairmanship of Mr. R. C. Munro Ferguson, M.P., to inquire into the subject. Through the agency of the Commissioners of Woods and Forests a school of forestry has been established in the Forest of Dean, and a movement is on foot for securing a suitable area of land in Scotland for the purpose of demonstrating scientific forestry. The board have taken steps to secure the establishment of at least two lectureships in forestry in England, and some of the leading universities and agricultural colleges have been giving attention to proposals under this head. The agricultural departments of the University College of North Wales, Bangor, and of the Durham College of Science, Newcastle-upon-Tyne, appeared to offer special advantages as centers of instruction in forestry, and grants in aid of the establishment of schemes of education in the subject will be made by the board to those institutions. The board hope that the arrangements thus made will result in a considerable improvement of the facilities available in this country for the acquirement of a knowledge of practical forestry."

THE following, according to *Nature*, is a summary of the prizes offered by the Belgian Academy for 1904 and 1905: For 1904, in mathematics and physics, critical phenomena in physics, viscosity of liquids, study of n-linear forms where $n > 3$, thermal conductivity of liquids and solutions, each a prize of 600

francs; unipolar induction of Weber, 800 francs. In natural sciences, the Cambrian rocks of Stavelot (Belgium), 800 francs; modifications produced in minerals by pressure, 600 francs; development of Amphioxus (see *Bulletin*, 1904, No. 4, for corrected announcement), 1,000 francs; effects of osmotic pressure in animal life, and Devonian flora of Belgium, each 600 francs; hetercecism of parasitic fungi, 800 francs; and physiological action of histones, 1,000 francs. All memoirs to be written in French or Flemish, and sent in before August 1, 1904. For 1905, in mathematics and physics, combinations of halogens, 1,000 francs; physical phenomena accompanying mutual dissociation of liquids, 800 francs; linear complexes of the third order, 600 francs; principal terms in the periodic deviations of the vertical, 600 francs. In natural science for the same year, effect of albuminoids in nutrition, reproduction of Dicyemidæ, formations intermediate between the Bruxellian and Tongrian in Brabant, geological age of certain Oligocene deposits in Belgium, sexuality of the individuals resulting from division of a single ovum in certain dicœcious plants; prizes, 1,000 francs for each of these five subjects; silicates of Belgian rocks, etc., 800 francs. In addition to these ordinary prizes the academy will award the following: June 30, 1905, a Charles Lemaire prize relating to public works; June 30, 1904, a Louis Melsens prize for applied chemistry or physics; December 31, 1904, a Charles Lagrange prize for terrestrial physics; on May 1, 1906, a Selys Longchamps prize for researches on the Belgian fauna; on December 31, 1904, a Théophile Gluge prize for physiology; and in 1906 a François Deruyts prize for higher synthetic or analytic geometry.

UNIVERSITY AND EDUCATIONAL NEWS.

The Board of Aldermen, New York City, has appropriated $5,000,000 for the erection of new school buildings, and $316,000 for recreation centers, vacation schools and playgrounds.

The Company of Goldsmiths has given £5,000 to the University of London for polytechnic work at the Institute at New Cross recently given by the company to the university.

We learn from the London *Times* that the negotiations between the hebdomadal council of the University of Oxford, the council of the senate of the University of Cambridge, and the senate of the University of London, with a view to the establishment of a system of mutual recognition of entrance examinations and certificates which exempt from entrance examinations, have resulted in a report by a committee of representatives appointed by the three bodies. On the report the London senate, who have adopted a resolution expressing their general approval of the suggested scheme, and their willingness to make an arrangement with the Universities of Oxford and Cambridge, or either of them, upon the basis of the proposal contained therein. The council of the senate of the University of Cambridge have already expressed their readiness to recommend that university to adopt the scheme. The matter is still under the consideration of the hebdomadal council of the University of Oxford.

Burtis Burr Breese, Ph.D. (Columbia), now of the University of Tennessee, has been appointed professor of psychology at the University of Cincinnati.

At Johns Hopkins University, Dr. C. K. Swartz has been appointed instructor in geology and paleontology, and Dr. James Barnes assistant in physics.

At a recent meeting of the board of trustees of Lehigh University the following were promoted to assistant professorships: In chemistry, Dr. W. B. Schober; in biology, Dr. R. W. Hall; in English, Dr. Chas. H. Whitman; in civil engineering, Mr. W. L. Wilson.

Dr. Louis G. Heyn has been appointed assistant to the chair of chemistry in Miami Medical College, Cincinnati.

Dr. Wm. Litterer has been elected professor of histology, pathology and bacteriology in the medical department of Vanderbilt University, to succeed Dr. Louis Leroy, resigned.

M. Mangin, of the Lycée Louis le Grand, has been appointed professor of botany in the Paris Museum of Natural History.

SCIENCE

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INAUGURAL ADDRESS OF PRESIDENT CHARLES RICHARD VAN HISE.

"And ye shall hallow the fiftieth year. . . . A jubilee shall that fiftieth year be unto you."—*Leviticus*, XXV: 10 and 11.

UPON behalf of the regents and faculty I thank the hundreds who have come here to join in the jubilee of the University of Wisconsin. We are delighted to welcome our guests from all parts of the United States, from Canada, from Europe, and from other parts of the world. Among the honored guests are official representatives of universities, academies and learned societies, of museums and libraries, bearing the congratulations of the institutions which they represent. That the chief learned institutions of the United States, a considerable number of foreign institutions, and many renowned scholars should regard this jubilee as of such consequence as to wish to take part in it, should encourage the state to continue to support and further to develop its university.

Fifty years ago the instructional force of the very small college here situated, even then called the University of Wisconsin, consisted of four members—three professors and one tutor. That year there were in attendance 56 students, all men, of whom only 41 were of collegiate grade. At that time the only building on the ground was old North Hall. This building still stands to give evidence of the architectural taste of those who designed it. Even in these early days Chancellor Lathrop and other men who controlled the policy of the university had visions of the

future. A wide avenue was laid out from the head of State Street to the crest of University Hill. Upon one side of the avenue, somewhat down the slope, was placed North Hall, it being planned to build a South Hall at the corresponding place upon the other side, and to locate the main building of the future university upon the crest of the hill. The dreams of the men of this time went even further than this, their plans providing for four dormitories. Later structures, and all succeeding plans, have left free the broad avenue above State Street, and the three buildings—North, South and University Halls—stand at the places assigned them by the men who, in their minds, created these structures before the foundation of any was laid.

At the end of the college year of a half century ago two students were graduated, Charles T. Wakeley and Levi Booth. We hoped the latter would sit upon the platform to-day as a guest of the university, but in the midst of his preparations for the long journey from Denver he was stricken with a serious disease. We deeply sympathize with him in his misfortune and hope for his speedy recovery. Upright and influential in the community in which he lives, a leader in his chosen vocation, we recognize him as a type of the thousands who since 1854 have been granted the degree of this university.

The morning is too far advanced to permit a narrative of the development of the University of Wisconsin from the time it bestowed its first blessing upon Charles T. Wakeley and Levi Booth. Many of us have read of, and some of those here knew of the struggle first for existence and, later, for advancement, during the twenty years from 1854 to 1874.

At the beginning of this period Chancellor Lathrop was still president; then followed the two years' incumbency of Chancellor Barnard; the headship of Professor Sterling for six years; the presidency of Paul Chadbourne for four years; and the four years' term of President Twombly. During these years great progress was made, with exceeding slowness and difficulty at first, haltingly always, but still progress. South Hall and University Hall, planned by the adventurous thoughts of the leaders of the early days, were built. Slowly recognizing that in a state university there must be no distinction between the sexes, the authorities of the university constructed Chadbourne Hall and gradually admitted women to all the privileges of the university. Substantially the same relations which now obtain between the high schools and the university were established, the certificates of high schools being accepted by the university, thus linking together in one unbroken chain the various branches of state education. The departments of law, agriculture and engineering were started. Finally, in 1872, the state, confessing that it had frittered away the university land-grants in order to attract settlers to Wisconsin, recognized its obligation, and gave to the university financial support to the extent of $10,000 per annum. This sum was small, but it was of profound significance as marking a fundamental obligation of the state, the ignoring of which would have delayed for many years the growth of the university, if it would not have indefinitely condemned the institution to obscurity. At the end of this period of twenty years the faculty consisted of 29 members; the students, exclusive of the preparatory class, numbered 310.

While the dawn of prosperity may be said to have appeared between 1870 and 1874, this latter year marked a new epoch in the university, for then came John Bascom, of Williamstown, Mass., as our presi-

dent. His administration continued for thirteen years, from 1874 to 1887. Preparatory work was now cut off, and transferred to the high schools. The College of Letters and Science, in these earlier years called the College of Arts and Letters, became consolidated and unified. Strong courses in the liberal arts were built up. While instruction in law and the applied sciences of agriculture and engineering increased somewhat, these subjects were still of very subordinate importance. During the administration of Dr. Bascom the instructional force increased from 29 to 49, the college students from 310 to 505. At the beginning of this administration there was one so-called resident graduate and at the end there were three. These advanced students mark the dawn of graduate work. During President Bascom's administration Assembly Hall and the first Science Hall were built. A few years later the latter was destroyed by fire; but so rapid had been the development of science in the university, that it was necessary to replace this building by a larger and better Science Hall and to provide separate buildings for chemistry and shop work.

Of deep significance with reference to the future was the fact that during these years ex-Governor C. C. Washburn, a man who had gained his fortune in the Northwest, gave a portion of this wealth to the university in the form of Washburn Astronomical Observatory. For more than twenty-five years this institution has been of inestimable advantage to students of science, and one of the important centers of productive scholarship at the university. It has thus helped to make the university known, not only in the state, but throughout the nation and the world. But, perhaps, most promising of all with reference to the future, was the action, in 1876, of the state legislature, which levied a continuing one tenth of a mill tax for the support of the university. In 1883 this tax was increased to one eighth of a mill and in later years the state grants have been further increased from time to time. Thus the state became committed to permanent and liberal financial support of the university.

While the alumni of the time of John Bascom remember with delight their student days, while they retain much that they then acquired, while they place above price the intellectual attainments which have enabled them successfully to deal with the world, probably for many of them the most treasured remembrance, the most potent influence which they carried away from the university, was the pervasive, mastering, moral power of John Bascom, whose personality wrought itself during his presidency into every graduate. The men of the days of Dr. Bascom may, or may not, now believe the tenets of his formal philosophy and ethics as given in his books, and as pounded into them in the class-room with sledge-hammer blows, but they believe and share in his high ideals, are inspired by his burning enthusiasm, and have thus been led to stand steadily for the right.

Following the administration of Bascom came that of President Chamberlin, from 1887 to 1892. During these years the new Science Hall was completed, the Law Building was constructed, and an appropriation was secured for a gymnasium. The instructional force increased from 50 to 68; the students from 505 to 1,092. The graduate students increased from 3 to 22. The work in law, agriculture, and engineering, which had been mere adjuncts to the study of liberal arts, received organization as colleges. This perfected the present organization of the university into Colleges of Letters and Science, of Engineering, of Agriculture and of Law.

A distinctive feature of Chamberlin's administration was the recognition of the importance of applied science. The profound necessity for raising the ancient art of agriculture to a science, in order that the land shall yield its fullest return, and that the occupation shall be dignified and ennobled, was fully appreciated. It was also seen that in this age, in which the world is for the first time being taken possession of by man, advance is largely in the hands of the engineer.

But, perhaps, of even greater significance than the development of applied science was the emphasis placed by Chamberlin upon scholarship and research—a definite attempt on his part to make the institution of which he was the head justify the name of university. To this end the system of university fellowships was established, scholars and investigators were added to the faculty, and the small beginnings of what, during the present year, became a graduate school appeared. The profound influence of this movement was not limited to the advancement of knowledge. It was equally important in the diffusion of knowledge. The man who is so full of enthusiasm for his chosen subject that he will burn his brains for its advancement is an inspiring teacher. He is the man who illuminates the knowledge of a thousand years ago with the discovery of to-day.

Following Chamberlin's administration came that of Adams from 1892 to 1901. On account of the ill-health of Dr. Adams, for the last two years of his administration, the charge of affairs was largely in the hands of Dr. Birge, and, after Dr. Adams's resignation in 1902, Dr. Birge was acting president until 1904. During these twelve years the gymnasium was finished, the large group of agricultural buildings, including Hiram Smith Hall, the Horticulture-Physics building and Agricultural Hall, were constructed. And, crowning all, by the joint efforts of the Historical Society and the university, the superb state library building arose, little short of the perfection of the structures of the ancient models. This building stands as a permanent and powerful influence for the promotion of the beautiful and appropriate in architecture.

During the twelve years' administration of Drs. Adams and Birge the instructional force increased from 68 to 180, the number of students from 1,092 to 2,877, and the graduate students from 22 to 115.

The applied sciences of engineering and agriculture rapidly developed during those years toward their true proportionate position in the university. The course in commerce, which may be called a course in applied arts, was organized. This course was at once a conspicuous success.

The rapid rise of applied education in the university during the administrations of Chamberlin and Adams alarmed some persons, who feared that the influence of the liberal arts was thereby endangered. As a matter of fact, during Chamberlin's administration the number of regular undergraduates in the College of Letters and Science increased from 217 to 711, and during the following twelve years to 1903, excluding those in commerce and pharmacy, from 711 to 1,232. During these same seventeen years the number of graduate students increased from 3 to 119.

In education, as in industry, when a fortunate development takes place which meets a need, it finds students adapted to it. Were it not for the courses of applied education in the university, it is safe to say that about 1,000 students now here would be somewhere else, and it is also certain that if technical education had nowhere developed in this country, a large proportion of this 1,000 students would never have entered a university. If one but compares the very slow increase in

the number of students at Oxford, where the old curriculum has remained largely intact, with the rapid increase in the number of university students where applied education has developed, he will not doubt the correctness of these statements. Applied education is mainly fed by a new constituency. While applied education may attract a few students, who otherwise would have gone into the courses of liberal arts, the tremendously increased momentum of the educational movement produced by the large numbers that flock to the universities probably has brought to the liberal arts more students than have been lost to it by the rise of applied knowledge.

While all this is true, it is fortunate that in this university the College of Letters and Science became so firmly established before agriculture and engineering were developed. So strong are the liberal arts and pure science, that I have no fear that the College of Letters and Science will lose its leading position in the university. For this college the union of the great Historical Library, the University Library and the Wisconsin Academy Library is most fortunate. This superb joint library is doing for the liberal arts what the various science buildings with their equipment have done for the pure and applied sciences, affording opportunity for the highest grade of work, an opportunity utilized by the students in those departments in which men of university caliber occupy the chairs. As evidence of the increasing power of the College of Liberal Arts is the recent growth of graduate work, the students in which, with few exceptions, are in the College of Letters and Science.

During the current year the schools of economics and political science, of history, of pharmacy, of education and of commerce, which had been organized under the administrations of Chamberlin and Adams, have been merged in the College of Letters and Science. These changes place all of the economic work done in the university in the Department of Political Economy; all of the botanical and chemical work heretofore done in the School of Pharmacy under the Departments of Botany and Chemistry, respectively. The purpose of the change is to correlate the work in these various lines with the work in the liberal arts, thus unifying the College of Letters and Science without weakening its various courses in any way. The courses in commerce and in pharmacy now have the same relation to the other courses of the College of Letters and Science, that the courses in civil engineering and electrical engineering have to the course in general engineering. The graduate work of the university, being located in all of the colleges and representing their culmination, has been organized into a school.

The catalogue of the present year shows an attendance of 3,150 students, and an instructional force of 228, while this commencement there will be conferred in course 361 degrees, of which 334 are bachelors, 17 masters and 10 doctors. If we contrast these numbers with those of fifty years ago, an instructional force of 4, 56 students and 2 baccalaureate graduates, is it surprising that we should cry: 'and ye shall hallow the fiftieth year. . . . A jubilee shall that fiftieth year be unto you'? And with our joyfulness there is a profound feeling of thankfulness to the state that has had the wisdom to be guided by men of such breadth of view as to provide liberally for the education of its children and of all others who care to share its educational hospitality.

While the achievements of the past fifty years are sufficiently great for celebration, the ideal of the state university is still more worthy of celebration. A score of years ago it could not have been said of

any state in America, that it had shown willingness to support a university of the highest class; but now several state institutions are recognized as standing in the first group among American universities. These institutions are mainly supported through taxation imposed by a democracy upon itself, for the sons and daughters of the state, poor and rich alike. Until this movement of the state universities had developed, the advantages of all educational institutions of the highest rank in all countries had been restricted to one sex, and even now it is practically impossible for the sons of artisans and laborers to enter the doors of many. In state institutions, where education is maintained by the people for the good of the state, no restriction as to class or sex is possible. A state university can only permanently succeed where its doors are open to all of both sexes who possess sufficient intellectual endowment, where the financial terms are so easy that the industrious poor may find the way, and where the student sentiment is such that each stands upon an equal footing with all. This is the state university ideal, and this is a new thing in the world.

The older universities of America have developed from small colleges. The earlier colleges of the United States were modeled upon Oxford and Cambridge. We turn for a moment to these institutions, in order to understand the nature of their influence upon the American university. If one were to name the most fundamental characteristic of these English institutions, it would be the system of halls of residence, involving commons, unions and athletic fields. The communal life of instructors and students in work, in play and in social relations is the very essence of the spirit of Oxford and Cambridge. It might almost be said that this constitutes Oxford and Cambridge. So fundamental have the English regarded the system that, from time to time, when the students have become too numerous for accommodation in existing quadrangles, another college has been founded upon the pattern of the others. If one were to consider the modern demands upon a university and especially the demands for wide opportunity to study science, pure and applied, he could scarcely imagine a more antiquated system than that represented at Oxford and Cambridge. Indeed, the old system has failed to meet the new conditions, and Cambridge especially is being rapidly modified under them, the various colleges contributing jointly for laboratories in pure and applied science, which may be utilized by the students of all the colleges. But, in making these radical changes, there is no thought of abandoning the halls of residence, with their communal life. Rather than surrender these, the authorities would, I believe, give up all modern lines of work. The college system of Oxford and Cambridge may seem absurd, but for some reason these universities have produced an astonishingly large proportion of great statesmen, writers and scientists. The men of Oxford and Cambridge have been largely instrumental in extending the empire of Britain over the earth; they have contributed liberally to the greatest literature of the world; they have furnished many fundamental ideas to science. In view of these stupendous results we need scarcely wonder that the Englishman is not eager to make over Oxford and Cambridge after the Yankee or the German model.

In the early days of the University of Wisconsin, when the only college buildings were North and South Halls, when Professor Sterling, his family, several instructors and a majority of the students lived in these halls, we had the essentials of the English system. Even when President Bascom came here in 1874 the remnants of the system still existed. Many of the men,

a majority of the women and a number of the instructors lived in the dormitories. In 1884 came the disastrous fire which destroyed the first Science Hall. There was urgent necessity for lecture rooms and laboratories to carry on the instructional work of the institution. Without any definite plan to change our system, indeed without any thought of the profound change which was being made in the character of the university, the students were turned from the dormitories, and halls of residence for men at Wisconsin were abandoned.

I have no doubt that every one of the alumni here, who in the old days lived in North or South Hall, feels that this change, although possibly necessary at the time, was most unfortunate. The professor in the class-room and the laboratory can do much for a student, and especially he can do much if he believes that one of the highest functions of a professor is that of a comrade. But, when the student goes out into the world, there is no other part of his education which is of such fundamental importance as capacity to deal with men, to see the other fellow's point of view, to have sympathetic appreciation with all that may be good in that point of view, and yet to retain firmly his own ideas and to adjust the two in fair proportion. Nothing that the professor or the laboratory can do for the student can take the place of daily close companionship with hundreds of his fellows. In the intimate communal life of the dormitories he *must* adjust himself to others. He must be genial, fair, likable, or else his lot is rightly a hard one. This fundamental training in adaptability to and appreciation of his fellows can only come from attrition between a large number of human units. These are the reasons, understood without statement by Englishmen, which make them adhere to the Oxford and Cambridge system. These are the reasons, profoundly comprehended by Cecil Rhodes, which led him to leave his entire fortune to establish the Rhodes scholarships at Oxford for the Teutonic race, knowing as he did from experience the influence of the communal life of Oxford in molding a world-conquering man. Believing, as he did, that the Teutonic people are to control the destinies of the world, he was deeply anxious that many of the best of the youth of Africa, Australia, Canada, Germany and America should gain the Oxford point of view.

Harvard, Yale, Princeton and Pennsylvania, originally modeled on the English university, and suffering under no accidental disturbance, have retained many of the features of this system to the present day. If the University of Wisconsin is to do for the sons of the state what Oxford and Cambridge are doing for the sons of England, if it is to do even what the eastern institutions are accomplishing for their students, not only in producing scholars and investigators, but in making men, it must once more have halls of residence, and to these must be added a commons and a union. At the commons the men meet one another each day; at the union they adjourn for close, wholesome, social intercourse. The union should be a commodious and beautiful building, comfortably, even artistically, furnished. When the students are done with their work in the evening, the attractive union is at hand, where refreshments may be had, and a pleasant hour may be spent at games, with the magazines, in a novel, or in social chat. The coarse attractions of the town have little power in comparison.

But, to build adequate halls of residence, commons and a union will require large sums of money. What more fitting thing for wealthy men of the state, who have gained their riches by taking advantage of its natural resources, than to turn back to the state some portion of their wealth for

this most pressing need? In no way can a man leave a more appropriate and permanent monument for himself than by building a hall of residence, a commons or a union. The state of Wisconsin is a safer trustee than any individual or corporation. The man who attaches his name to a hall, a commons or a union will fix that name as one to be loved in the minds of the unnumbered sons of the state that during the centuries to come will flock to the University of Wisconsin to obtain intellectual training, to develop high ideals, and more than all, to gain sterling, vigorous, self-sufficient, adjustable manhood. May I not hope that before the end of this jubilee year the money will be forthcoming to provide for these needs, so that the necessarily very large demands upon the state may be restricted to supplying additional buildings, equipment and instructional force made imperative by the extraordinary increase in number of students at the university?

We have now very briefly sketched the effect of *one* of the influences of the English upon the American university, but there remain other influences to be considered. The original American college was essentially a counterpart of the English college; indeed, this was true well into the nineteenth century. But, in the second half of that century, important American modifications appeared to better adapt the college to our needs. Perhaps the most important of these was the development of pure science and its assimilation by the college of liberal arts. This radical change met a much more ready welcome in the west than in the east. For a long time in the east science was regarded as an intruder, and was only slowly and partially admitted to full fellowship with the studies of the old curriculum. When science was finally, grudgingly, given a place in some of the more important institutions, it was made an appendix to the college, and in a number of cases a new name was attached. This is illustrated by the Lawrence and Sheffield Scientific Schools. In the west science did not receive separate foundations, although the courses in which science was the major line of work were at first kept separate from the old course in which the classics and mathematics dominated. A new degree was given for science, which, for many years at least, was regarded as inferior to the A. B. degree. To the present time in some institutions of the east the distinction between work in science and work in the old curriculum is retained; and in one the organization of the college and the scientific school are so nearly independent that the college has introduced science into its courses, thus duplicating much of the work of the school. And in another, where the separate organization of the classical college and the scientific school is more or less formal, different degrees are granted in the college and in the school, without regard to whether the subjects pursued by the students receiving the different degrees are the same or not. In the state universities where the college and school of science were never made separate foundations, and where with the great increase in number of subjects, freedom of election has been introduced, it has become recognized either that there should be a separate degree for every group of studies, or else one degree for any group of liberal studies. This latter alternative has been accepted by the leading state universities, and, in this respect, it is believed that they are leaders in educational progress, although not pioneers, for Johns Hopkins led the way. No one now doubts the right of pure science to full admission to the list of subjects which may be pursued for a liberal education. Not only so, but it is recognized that the scientific spirit has permeated and vivified the studies of the old college course.

Scarcely less noteworthy than the winning of a place for pure science in the university has been the rise of the great groups of studies classified under political economy, political science, sociology and history. From a very subordinate, almost insignificant, place in the curriculum, they have risen to a place not subordinate to classics or science.

The development of these subjects in the universities is destined to have a profound influence upon governmental progress. In the university men are trained to regard economic and social questions as problems to be investigated by the inductive method, and in their solutions to aim at what is best for the whole people rather than at what is favorable to the interests with which they chance to be connected. Such of these men as are filled with a burning enthusiasm for the advancement of the race, are capable of great accomplishment, for they possess the enlightenment upon which wise action may be based. Already men who have studied history, economics, political science and sociology in the universities have achieved large results in the formulation and enforcement of the written law, and in the growth of a healthy and powerful public sentiment. Soon such men will be found in every city and hamlet, leading the fight against corruption and misrule; but, even more important and vastly more difficult, leading in constructive advance. In these men lies, in large measure, the hope of a peaceful solution of the great questions deeply concerning the nation, some of which are scarcely less momentous than was that of slavery.

But the western people were not content with the expansion of pure knowledge. They demanded schools of applied knowledge. This demand was early recognized in this and many other universities by the organization of law schools, which deal with subjects closely concerning each individual. So important is the subject of the law that these schools of applied knowledge were very early established and their subsequent development has been uninterrupted.

After science found its way into the universities, a natural, indeed an inevitable outcome of its admission into the institutions supported by the states demanding both culture and efficiency was the rapid growth of the applied sciences, of which the more important are agriculture, engineering and medicine. But the people of the west went even further than this and demanded that language, mathematics, political economy and history should be so taught as to serve the man of affairs, and thus there arose here the first strong course in commerce in the United States. Such a course has now been introduced into a number of other institutions, including one of the principal universities of the east. Whether one deplores or approves the rise of applied knowledge in the universities, it is an inevitable movement which, for my part, I expect to see extended. In the recognition of the intellectual power gained by pursuit of applied knowledge and its extreme importance in the development of the nation, the state universities of the west have been at least abreast of the eastern institutions.

From the foregoing it is plain that the most important American modifications of the English college system have been the introduction and development of pure science and applied knowledge. While these modifications represented a great broadening of the classical college, they did not produce a proportional increase in the height of the edifice of knowledge.

This leads us to another influence upon the American university, which has profoundly modified it—the German influence. Some thirty years ago Johns Hopkins, at Baltimore, left his fortune to found a university, and Daniel C. Gilman was called

as its first president. President Gilman saw an opportunity for a new type of institution in America. Having visited universities abroad, he became convinced that the great need was for a university upon the German model, where investigation and the production of scholars should be the dominating ideas. The ablest scholars at home and abroad were invited to fill the chairs of Hopkins. The success of this new type of institution in America was almost instantaneous. Not only did Hopkins soon become a chief center of research in this country, but it sent scores of men with Hopkins training as professors to other universities. Even earlier than the foundation of Hopkins, a steady stream of students was returning to America from German universities, bringing with them the German spirit. After the foundation of Hopkins this stream increased rapidly in size. The students trained at Hopkins and in Germany could not fail to influence the more important institutions of the country. There slowly appeared upon the stronger of the old colleges a superstructure.

This upward movement was more quickly felt in the east than in the west, but, even in the west, here and there, a scholar in the state universities appeared who was not content to do instructional work alone. At Wisconsin the first of these were Allen and Irving. Chamberlin, an investigator, believing in research in state universities, when he became president at Wisconsin, began systematically to develop scholarship and research. Other state universities have gone through similar stages of growth. Thus both in the east and in the west the graduate school has arisen upon the college, and its influence permeates all parts of the university. But the growth of the graduate school in the American university has been slow. The cost of such a school, relative to the number of students within it, is large, and it has been assumed that the state universities especially must not go too far in the development of such a school. No mistake could be so fatal to the power for good of the state university. In Germany, where the universities mainly devote themselves to the class of work done in the graduate school, the universities are, without exception, supported by the government. The German statesman regards it as a matter of course—as settled beyond dispute—that the production of scholars and investigators at the university is a necessity to the nation. To them, he believes, is largely due the great position which Germany has taken during the last half century. It was after the disasters of the Napoleonic wars that the German educational system was reconstructed, at the top of which was the university. The rise of the university has been correlative with, and one of the chief causes for, the rise of Germany.

If time permitted, I should be glad to consider the effect of university work upon the mind of the student, that is, work in which he takes a share as an investigator and during which he acquires the spirit of research. It would be easy to show that the qualities of mind gained by such work are those which best fit him for the struggle of life—which best fit him to handle difficult business, social and economic problems. In Germany the university scholar is a man of affairs. He is found in all important divisions of administration. Almost every prominent German and Austrian professor is an official adviser to the government. Already, in America, we see the beginning of this movement. University professors are asked to serve on tax commissions, in the valuation of railroads and in various other capacities. Within the next half century the number of such men in these and similar positions will increase many fold. The college-trained man,

and especially the university-trained man, is, directly or indirectly, to control the destinies of the nation.

But while the professor performs important service outside the university, his greatest service is his own creative work and the production of new scholars in the laboratory and seminary. I unhesitatingly assert that there is no investigation of matter or force or mind to-day in progress, but to-morrow may become of inestimable practical value. This could be illustrated by various investigations which have been made here. It is easy to show that the discoveries at the University of Wisconsin bring vastly more wealth to the state each year than the entire expenditure of the institution, but to tell of them might seem like placing too great emphasis upon our own achievements, and I, therefore, turn elsewhere for illustrations.

Scarcely more than a century since, Franklin began studies upon the nature of lightning. Later the character of electrical force was during many years investigated with remarkable power by Faraday. If, during these studies, some one had said: 'Of what practical value can be the discoveries of Franklin and Faraday?' no one could have given the answer. Had this work been paid for by the state it would have been easy to show to the legislature that such a foolish waste of money was wholly unwarranted. But out of the discoveries of Franklin and Faraday, and those who followed them, has come one of the greatest material advances that the world has known. Electricity has become the most docile of the forms of energy. It serves to carry to distant points the power of Niagara. It is the nerves which make all the world one body, which bring to us instantaneously all the happenings in every quarter of the globe, which puts in our ear the vibrations of the voice of our friend a thousand miles away. Through increased knowledge of nature the peoples of all nations are being made slowly, haltingly, with occasional disastrous wars, into one family. And this is largely the result of recondite studies upon subtle forces, which, even now, we can not define, but which we can utilize.

A striking case of the profound service of the investigator is furnished by the studies of Pasteur and Koch. If, a half century since, a legislator in France had wished to be humorous at the expense of the scientist, what better object of derision could he have found than his countryman, Pasteur, who was looking through a microscope at the minute forms of life, studying the nature and transformations of yeast and microbes? And yet, from the studies of Pasteur and Koch, and their successors, have sprung the most beneficent discoveries which it has been the lot of man to bestow upon his fellow men. The plague and cholera and yellow fever are controlled; the word diphtheria no longer whitens the cheek of the parent; even tuberculosis is less dreaded and may soon be conquered; aseptic surgery performs marvelous operations which, a few years ago, would have been pronounced impossible. The human suffering thus alleviated is immeasurable.

These illustrations are sufficient to show that no knowledge of substance or force or life is so remote or minute, although apparently indefinitely distant from present practise, but that to-morrow it may become an indispensable need. The practical man of all practical men is he who, with his face toward truth, follows wherever it may lead, with no thought but to get a deeper insight into the order of the universe in which he lives. It can not be predicted at what distant nook of knowledge, apparently remote from any practical service, a brilliantly useful stream may spring. It is certain that every fundamental discovery yet made by the delving student has

been of service to man before a decade has passed.

Already at Wisconsin here and there a scholar has arisen whose most elemental thought is to see deeper into the order of nature. Let the university search well for such spirits and give them unbounded opportunity, for they are to be benefactors, not only of the state, but of the entire earth; for a new truth, a new principle, is not the property of any state, but instantly belongs to the world. May men of creative power, trained by Wisconsin, leave our doors in ever-increasing numbers, until they become a great enlightening influence in the state and the nation! The final and supreme test of the height to which a university attains is its output of creative men, not in science alone, but in arts, in literature, in ethics, in politics and in religion.

I, therefore, hold that the state university, a university which is to serve the state, must see to it that scholarship and research of all kinds, whether or not a possible practical value can be pointed out, must be sustained. A privately endowed institution may select some part of knowledge and confine itself to it, but not so a state university. A university supported by the state for all its people, for all its sons and daughters, with their tastes and aptitudes as varied as mankind, can place no bounds upon the lines of its endeavor, else the state is the irreparable loser.

Be the choice of the sons and daughters of the state, language, literature, history, political economy, pure science, agriculture, engineering, architecture, sculpture, painting or music, they should find at the state university ample opportunity for the pursuit of the chosen subject, even until they become creators in it. Nothing short of such opportunity is just, for each has an equal right to find at the state university the advanced intellectual life adapted to his need. Any narrower view is indefensible. The university should extend its scope until the field is covered from agriculture to the fine arts.

The barrenness of America in the creation and appreciation of literature, music and art is the point upon which Europe charges us with semi-barbarism. If the university does not become the center for the cultivation of the highest capacities of the human mind, where is the work to be done in this country? In America there is no other available agency. This work must be undertaken by the university, or else remain undone.

If the people of the United States are to cease being mere money getters, if they are to accomplish more than material advance, if they are to have proportional development, the university must give opportunity for training in all lines of human endeavor.

If the University of Wisconsin is to do for the state what it has a right to expect, it must develop, expand, strengthen creative work at whatever cost. Only by so doing is it possible for the university to serve the state in the highest way. For my part, I look forward with absolute confidence to the liberal support by the state of a school whose chief function is to add to the sum of human achievement. I am not willing to admit that a state university under a democracy shall be of lower grade than a state university under a monarchy. I believe that legislatures elected by all the people are as far-sighted as legislatures that represent an aristocracy. A great graduate school will be realized at some state university during this century. Is Wisconsin to have this preeminent position?

We are now able to suggest the ideal American university—one which has the best features of the English system with its dormitories, commons and union; one which includes the liberal and fine arts and the additions of science and applied science; and one which superimposes

upon these an advanced school modeled upon the German universities, but with a broader scope. In such a university the student in the colleges of liberal and fine arts has opportunity to elect work in applied science, and thus broaden his education. He feels the inspiring influence of scholarship and research, and thus gains enthusiasm for the elementary work because it leads to the heights. The student in applied knowledge is not restricted to subjects which concern his future profession, but he has the opportunity to pursue the humanities and the fine arts, and thus liberalize his education. He, too, feels the stimulus of the graduate school, and, if one of the elect, may become an investigator and thus further ameliorate the lot of mankind by new applications of science to life. The student in the graduate school, primarily concerned with creative scholarship, may supplement a deficient basal training by work in the liberal arts and in the schools of applied knowledge. Thus the college of liberal arts, of applied knowledge and of creative scholarship interlock. Each is stronger and can do the work peculiar to itself better than if alone. This combination university is the American university of the future, and this the University of Wisconsin must become if it is to be the peer of the great universities of the nation.

Wisconsin is among the state universities which have this opportunity open to them. Many of the states have divided their grants among several foundations, supporting at different localities, schools of liberal arts, of agriculture, of medicine and of mining. In Wisconsin there is only one institution which attempts to do university work. Public and private funds alike, which are to go to a university, should come to that institution. This statement does not imply lack of appreciation of the excellent and very important work done by the colleges of the state. May they continue to thrive; may they continue to have the support of the citizens of the state; for the many thousands of students that during the next half century are continuously to demand a college education in this state can not be accommodated in one institution. Collegiate work should be done at several centers within the state, but professional and university work is so expensive and the different schools and colleges so closely interlock, that the best opportunities can only be furnished in the various fields in the university. At a university of the first rank the opportunities for instruction in the fields strongly covered are superior to those which can be offered in an institution devoted to a single field. Wisconsin has fortunately escaped the fatal mistake of subdivision of its university effort. With the concentrated support of the state, public and private, there is no reason why the University of Wisconsin should not do in every line as high grade work as any in the country. My faith is such that I look forward with confidence to the future, with profound conviction that the breadth of vision, which has enabled this institution to grow from small beginnings to its present magnitude, will continue to guide the state, until a university is built as broad as human endeavor, as high as human aspiration.

THE UNIVERSITY OF MONTANA BIOLOGICAL STATION AND ITS WORK.

THE University of Montana Biological Station at Bigfork, on Flathead Lake, opened its sixth annual session on July 18, the session lasting for five weeks. The circular giving announcement of the work for the season contains a number of new and choice original photographs, giving views of the region in which the station is located, including sketches of Flathead

Lake, the forests adjacent and the mountains in the vicinity.

This station was started in 1899 as an experiment, in a state as large as Ohio, Pennsylvania and Michigan combined, with less than two inhabitants per square mile, and with biological study at a low ebb in the schools of the state. It was intended to fill the double mission of affording a place where a few might find suitable place for carrying on study in a field comparatively unknown, and to supply a stimulus for the teachers and young naturalists, few of the latter having at that time yet appeared.

It is practically impossible for Montana people to attend eastern summer schools. One reason is on account of railroad expense. At present writing rates are advertised from Chicago to San Francisco and return by a different route at identically the same price as from Missoula to San Francisco and return, and at the same price as one way fare from Missoula to Chicago. For a few days in June one may get out of the state at a low fare. But Chicago students may visit Flathead Lake with little more expense for the return trip than return trip from Lewistown, Mont., by taking advantage of reduced rates. Moreover, the summer is the pleasant time for one to be in the mountains, and most people wish to stay during the pleasant season. Owing to the fact that railroads grant few privileges to Montana people, and Montana people wish to stay at home during the most pleasant portion of the year, it seemed advisable to look toward preparing a place at home where advantage could be taken of beautiful scenery, healthful recreation and balmy mountain air, in a locality where 'unknown' is written on half the objects that greet the eye.

The station has accomplished more than was anticipated at its inception five years ago. The small summer laboratory has long since ceased to accommodate the work of those in attendance. But, owing to the delightful weather prevailing at this season, it matters little whether the work be carried on indoors or not, unless table room and apparatus are needed. Students from twelve states have been present at different times, in addition to the many that have come from Montana. Already the schools of the state are feeling the effect in the work in zoology and botany, not only through the attendance of high school and grade teachers, but through the material which is collected and the printed matter prepared for distribution.

The printed matter thus far issued by the University of Montana, emanating from the work at Flathead Lake, covers 360 printed pages of close type, with 65 plates and 40 other illustrations, all from original photographs or drawings. In addition to this, numerous papers have appeared in various publications, greatly increasing the scope of the work.

The study of the birds of the Flathead Lake country has been carried on by P. M. Silloway, the well-known ornithologist. The first publication included 128 birds. This study has been carried on continuously for four seasons, usually from June until September. A second contribution increased the list to 137, which includes the summer residents and a few early fall migrants. This careful systematic work is especially valuable in making a good beginning in the study of the birds in a region not well known. The careful oological notes are full of interesting observations. Frequent references are made to calamities befalling old birds or their young. It is shown that birds occupy unfinished nests, which contain eggs. This may be due to the laziness or shiftlessness on the part of the mother, or to her inexperience, which

prevents rapid working, or to the destruction of a first nest. The finding of a nest of the willow thrush, which ordinarily builds close to the ground, six and one half feet up in a tree, will be of interest to students of animal intelligence, as illustrating the change of habit due to environment. The region in which the nests occur may overflow annually.

Among the interesting notes concerning the distribution of Montana birds, that of the occurrence of the varied thrush, *Hesperocichla nævia* (Gmel.), is of importance. This songster heretofore has not been reported east of the Coeur d'Alene Mountains in Montana. It was found in abundance at the head of Swan Lake, and by reliable observers in the neighborhood it was reported to be a permanent resident and one of the earliest in nidification. The olive-backed thrush, *Turdus ustulatus swainsonii* (Cab.), was found in numbers at the head of Flathead Lake, though in equally advantageous localities seventy miles farther south it was scarcely represented. At Selish, on the Jocko River, we noted the long-tailed chat, *Icteria virens longicauda* (Lawr.), abundant in numbers and in full song, though we were too early for the nesting season. A small colony of Holboell's grebe, *Colymbus holboellii* (Reinh.), was found nesting on Swan Lake, and several sets of eggs, in complements of three, four and five eggs, were taken. Specimens of pigeon hawk, *Falco columbarius* Linn., Richardson's Merlin, *Falco richardsonii* Ridgw., pygmy owl, *Glaucidium gnoma* Wagl., pileated woodpecker, *Ceophloeus pileatus* (Linn.) and the like were taken.

Principal Silloway is now pushing his ornithological investigations in other directions, to regions not visited by ornithologists, with the idea of later preparing a work on the birds of the state.

The biological station is favorably situated for carrying on work in plant ecology lines. This is due to the fact that within a radius of ten miles there are several different climates, giving rise to different plant formations. The west side of the valley at the head of Flathead Lake and the Mission valley at the south end of the lake have little rainfall, and a typical prairie vegetation is the result. Kalispell, situated in the prairie, has a rainfall of about sixteen inches per year. The east side of the valley has a greater precipitation and a forest formation results from this. Columbia Falls, situated at the base of the mountains on the east side of the valley, has a rainfall of a little over twenty-one inches per year. This town is only a short distance from Kalispell. The mountains near the station are very accessible, so that alpine conditions can be easily studied.

The botanical work done in the summer of 1902, by Harry N. Whitford, was entirely along forest ecology lines. A map was made comprising some 96 square miles, which are situated mostly in the forest formation, but reach into the edge of the prairie. Five well-defined plant societies were noted. These are distinctly related to the amount of water in the soil, and that in turn depends mainly on the topographic diversity. The hydrophytic societies are closely associated with a great amount of water in the soil. They are located along streams and around lakes, and have plants in them resembling very much those in similar situations in the eastern part of the United States.

The mesohydrophytic societies are usually adjacent to the meadows. Because the Engelmann spruce is the principal tree in these they are called the Engelmann spruce societies. Other trees associated with the spruce are the narrow-leafed cottonwood,

the aspen and the white birch. Bordering the Engelmann spruce stands are the western larch-Douglas spruce societies, so called because they are the predominating trees. The western larch-Douglas spruce type of a forest is decidedly mesophytic. In places where the soil contains nearly as much water as that in the spruce society, the silver pine (*Pinus monticola*), the lowland fir (*Abies grandis*) and the western arborvitæ are found. The lodge-pole pine is scattered all through the mesophytic area, sometimes forming almost pure stands in it. There is but little doubt that its presence in the region is due to the influence of forest fires. It is a tree that fruits well at an early age. This gives it a decided advantage over the other trees, because when frequent fires occur it is likely to be the only one with fruiting trees on the burned areas.

In places in the forest formations there are 'sandy pockets.' These are likely to have prairie vegetation. The absence of trees is probably due to the fact that the sand is not capable of holding the water sufficiently long to enable trees to get a start. Closely associated with these 'sandy pockets' and bordering the prairie formation are the bull pine-Douglas spruce societies. The bull pine (*Pinus ponderosa*) is the most xerophytic of the conifers and thus extends further out into the prairie region than any of the others.

A collection of the other plants of the region was made and their ecological distribution was noted. This collection has been deposited in the herbarium of the Field Columbian Museum at Chicago. Careful studies were not undertaken in the alpine regions, though in hasty trips made into these regions some problems were noted for future studies.

Extensive botanical collections were made in 1901. The station and the New York Botanical Garden worked conjointly during the season from June to September, Dr. D. T. MacDougal and Wilson P. Harris gathered nearly a thousand numbers, the latter looking particularly after the lichens and mosses. The lichens have been identified by Carolyn W. Harris, the mosses by Mrs. Elizabeth G. Britton. Duplicates are in the collections of the University of Montana and the New York Botanical Garden. A check list of lichens and mosses has been issued, giving twenty genera and sixty-seven species of lichens and nineteen genera and thirty-seven species of mosses, a total of thirty-nine genera and one hundred and four species.

The collection of flowering plants was gathered from territory much of which had never been visited by a botanist. The Mission range, fast becoming known on account of its grand scenery, was examined almost from end to end, a distance of nearly a hundred miles. The valleys at the base of the range are from 2,300 to 3,000 feet elevation, while the summits reach 10,000 feet. Excursions were made with pack horses into the Swan range, where specimens were gathered from snowbanks and the edge of glaciers. The alpine willow was found abundantly at 7,500 feet, the stunted trees, but a few inches in height, bearing flowers. Days were spent in crawling over steep mountains, with a heavy pack as an encumbrance, without road or trail, in search of specimens. The large series shows the result. Each number was taken in duplicate, one set being deposited in the herbarium at the New York Botanical Garden, the other at the University of Montana at Missoula. The identifications were by P. A. Rydberg, the well-known authority.

Some observations on the forests are worthy of notice. The alpine fir, *Abies lasiocarpa* (Hook.) Nutt., is found at a

low elevation, certainly as low as 3,000 feet. A few scattering trees are found on the banks of Swan River near the laboratory, while forests of this species may be seen at the upper end of Swan Lake. Here the trees are large enough for logging. A tree at 3,000 feet elevation aged 120 years was one third larger in diameter than one aged 200 years at 7,500 feet. The age of the largest trees at elevations about 7,500 feet is about 200 years.

The alpine pine, *Pinus albicaulis* Engelm., takes the place on the higher slopes of the yellow pine, *Pinus ponderosa* Laws., on the lower levels. The yellow pine is the pioneer, pushing out into the dry and unoccupied valleys, preparing the way for those species requiring more moisture. The alpine or white-barked pine can not tolerate moisture. It is practically absent in the protected amphitheaters at high elevations, leaving the alpine fir to hold full sway. The alpine pine takes the dry slopes, exposed to the sun, or the rocky ridges where soil is scanty and where existence is had by the severest struggle. It prefers a narrow and storm-swept ridge, or a dry and scorching slope, to the quiet, protected, but damp slope. Its gnarled, twisted and broken trunk is in marked contrast to the tall, tapering and stately alpine pine on the opposite side of a ridge, but a few rods away.

The lodge-pole pine, *Pinus murrayana* 'Oreg. Com.,' is a follower of other species. After the yellow pine, tamarack, or Douglas spruce has made a dense forest, making a rich and damp soil, a fire may clear the forest. Then the lodge-pole springs up, as thick as it can stand. The region adjacent to the laboratory shows this, where tall boles of monster tamaracks or yellow pines, amidst dense masses of younger lodge-poles, tell a mournful tale of magnificent forests but recently laid waste. Its ability to produce cones in a single year, coupled with the early maturity of the tree, six or seven years, gives the lodge-pole a firm hold on the soil. But it is its own destroyer, since it is intolerant of shade and may be squeezed out again by more hardy rivals. How many successions of species of forest trees there may have been will never be known. The evidence points to three in recent times: Yellow pine —Douglas spruce, tamarack and lodge-pole.

Extensive collections have been made of the fresh-water invertebrata of the western end of the state. By means of a canvas boat the soundings of mountain lakes have been made, and the life of the waters gathered for future study. These soundings and dredgings have been made during the past five summers, and much material and information has accumulated as the result. Lakes hitherto called bottomless are known definitely. Flathead Lake, covering more than three hundred square miles, has at no place a depth of more than three hundred feet. Enough work has been done to prove that at some seasons of the year the entomostraca have a decided diurnal or nocturnal movement, ascending to or toward the surface at night or during cloudy weather, descending when the sun shines. The depth to which they descend is from twenty-five to thirty feet. This corresponds almost exactly to the limit of vision when the white net is lowered into the clear and blue water. Again, for some unknown reason, certain species seek the surface during the hottest weather and brightest sunshine, when they may be dipped up with a tin-cup. *Daphnia thorata* Forbes was exceedingly abundant in 1901, when Forbes made his visit to the region, but at no time in the five years' collecting have we found it in large numbers. There is much room for study of the plankton of the region, and the waters at such varying

elevations, lakes at 3,000 feet and others at 9,000, offer a fine field for the limnobiologist. A few seasons of collecting during the summer whets the appetite for more extended study during the entire season.

A number of observations on the geology of the country have been made, suggesting fruitful fields for more extensive study. It has been shown conclusively that the northern end of the Mission range has been smoothed by the action of ice, a smaller mass from the south meeting a larger field from the north, the latter deflecting the former directly back—southward, but on the opposite side of the Mission range. It has been shown that the old bed of the Swan River was northward along the base of the Swan range, where it emptied into the Flathead near Kalispell, whereas it now empties into Flathead Lake at the northeastern corner.

Much of the surface geology of the Flathead and Mission valleys has been determined. It has been shown beyond doubt that the present outlet of Flathead Lake is comparatively new, and that the former outlet was through the western arm, near Dayton Creek. The present level is several hundred feet lower than the former level, the new outlet uncovering the rich valley at the head of the lake. The moraines at the foot of the lake and at other places in the Mission valley on the Flathead Indian Reservation have been brought to light and partially described. The moraine at the foot of the lake is four hundred and fifty feet high, and many miles long. It has not been followed westward. From the lake one rises by a steep wagon road to the summit, descending on the opposite side to a plain lower than the lake.

Incidentally shells have been gathered from various portions of the state. While few mollusks are to be expected from a region of rushing rivers and cold lakes, with small amount of lime in the water, yet the collection is very satisfactory and the number of species for the state is growing. The entire list for the state numbers but sixty species and varieties. Of these twenty-five have been collected west of the main range of the Rockies, forty-two from the eastern slope. Seven are found on both sides of the range. One new species and several new varieties have been described. No collecting for shells has been made along the Missouri or its tributaries except at Wibeaux (by Homer Squyer), on the extreme eastern border. The wide territory along the Missouri has not yet been touched.

In entomology extensive collections have been made, principally of the lepidoptera. Only the diurnals have been determined. These show that the butterflies of the northwest are in much confusion, and the study is beset with great difficulties. The life history of a large number is as yet 'unknown.' Indeed, this stares one in the face on almost all occasions, wherever he gathers material in the state. So interesting did the study of these airy insects become that a systematic report has been prepared and is now in press. This report will include photographs of all the specimens obtainable, with keys for identification. It is based on the collections of the writer; of Earl Douglas in the Ruby Mountain and the Madison range; of Professor R. A. Cooley, of Bozeman; of E. N. Brandegee, of Helena, and of the late C. A. Wiley, of Miles City. It lists about one hundred and twenty-five species. A few points may here be mentioned. *Parnassius smintheus* seems to be scarce at higher elevations in the western end of the state, but is often abundant at 4,000 feet, and has been taken on the shore of Flathead Lake, 2,900 feet. *Vanessa J. album* is

credited in all works as being everywhere scarce. It has been taken at Swan Lake by the hundreds, a dozen being taken in the net at a time. *Anosia plexippus* is scarce in the western slope. The milkweed has but lately been introduced along the railroads, and its numbers are increasing annually. But it is yet rare. Its mimic, *Basilarchia disippus,* has been taken at Gold Creek, on the Northern Pacific, where the last spike was driven, about fifty miles west from the summit of the range. It has not been taken further west. There is no doubt but that *Argynnis Edwardsi* and *Argynnis nevadensis* are synonyms, as shown by specimens from various localities, and by specimens in the Wiley collection and that of the writer, identified by Edwards himself. At Missoula butterflies were on the wing in 1903 as early as February 19, when *Vanessa californica* was taken. The cosmopolitan *Pyrameis cardui* is to be taken everywhere, while *Pyrameis atalanta* is very rare west of the range. As the state contains portions of four faunal areas, the Great Plains, the Hudsonian or Canadian, the Great Basin, and the Boreal, a diversified entomological life is to be expected. There are certainly many Pacific forms that have followed up the Columbia River and its tributaries. Indeed, it seems that the Pacific forms may have more invertebrate representatives in the western part of the state than those from the great basin. At any rate, many additional facts on distribution are recorded.

The dragon flies, numbering less than sixty species, about one half as many as are to be found in New York state, have been determined, and are in manuscript. One species, *Calopteryx yakima,* considered by Calvert to be synonymous with *C. æquabilis* from the eastern side, has been found at Flathead Lake. Years ago Hagen described the species from specimens taken at Lone Tree, near the Yakima River, Washington. He believed that it crossed the range from the east at some point 'above' (north of) Missoula. The finding of the species proves the soundness of his reasoning, and brings the species very close to the main range. It also confirms Calvert's view of the relationship between the eastern and western specimens. Further reference to this insect will be found in *Bulletin University of Montana,* Biological Series, No. 3.

Among the various collections that have been made at the station may be mentioned the splendid series of photographs. These have been taken at all altitudes from the level of Flathead Lake to the 10,000-foot summits. They show various geological and physiographical studies and formations of the mountain ranges, and serve to illustrate the changes that have taken place during ancient and recent times. Negatives have been made of the forests, trees and flowers, of large animals, birds and insects, illustrating phases of both animal and vegetable life. Many of these negatives are exceptionally good, and make remarkably good slides. When colored they show the views quite life-like. Altogether more than a thousand negatives have been secured. From these a book of photographs has been made. From these as samples it is possible to make selections, and slides will be made for those who may be able to make use of them. The book will be sent to responsible persons for examination with a view to selection of slides.

Some of the studies here given show the charm of a new field to those who have been privileged to visit it. Numerous problems yet awaiting solution could easily be proposed. With so many lakes close by, and others not far away, the daily, monthly and annual movements of entomostraca afford ample opportunity for the limnobiologist. The alpine heights, the vast for-

ests in the Lewis and Clarke reserve, the glaciated valley, the numerous mountain chains, the unknown animal and vegetable life, suggest numerous topics for the thoughtful student.

There is no reason why eastern friends should not make the laboratory a rendezvous during the summer. One can recreate to the fullest and yet have a definite object in view. It is impossible to visit the mountains and see them without some one of experience to help the visitor around. Vacation is gone before the wanderer 'hits the trail' he is seeking. His inexperience leads him to undertake things he can not do. Montana can not be seen from the car window. One must push out of the canyons. He is unwise who enters the pathless forests alone. They are too vast, the hills are on too large a scale, and the difficulties are too great to be entered hastily.

From the laboratory the collector may easily reach alpine heights, where grand scenery is spread before him. He may gather material for future study, undertake serious study indoors, more serious and more difficult study out of doors, and have the help and wisdom of those who have spent years in wandering in search of such places as many wish to visit and such specimens as many would gladly gather. The building is entirely inadequate to the demands of those attending, but it is believed that when the merits of the station are known and its opportunities fairly presented it will not lack for suitable quarters.

The summer session opened on July 18, and continues five weeks. The illustrated pamphlet, giving full information, will be sent to any one requesting it.

Morton J. Elrod.
University of Montana,
Missoula, Mont.

SCIENTIFIC BOOKS.

The Evolution of Earth Structure with a Theory of Geomorphic Changes. By T. Mellard Reade. New York, Longmans, Green & Co. 1903.

This work may be considered as a sequel to the well-known volume entitled 'The Origin of Mountain Ranges,' by the same author, which appeared in 1886. It is divided into three parts. The first of these treats of 'Geomorphic Changes' and deals with Regional Oscillation, the Relation of Continental Evolution to Mountain Building, Continental Growth and the Sub-Oceanic Configuration of the Earth's Crust. The second part deals with the 'Dynamics of Mountain Structure' and the experimental elucidation of the same, while the third part is made up chiefly of reprints of papers by the author on subjects allied to those just mentioned, which papers have appeared at various times and in different journals.

The author first cites numerous cases where there is distinct evidence of changes of level in the earth's crust, with concomitant bending of the strata composing the crust. He considers the principle of isostacy as quite inadequate to the explanation of these movements, since the mass of the solid earth involved in upward movement is entirely too great to be explained by any sedimentation which has taken place in the same period of time. These changes of level the author believes must be due to change in bulk of certain sections or portions of the earth's crust, without change of mass; the irregularities in the earth's surface, in fact, arising from differences in the specific gravities of the earth's crust and the underlying matter. These specific gravities are not stable, but are subject to slow changes consequent upon changes of temperature. A rise in temperature and increase in volume create a protuberance; a fall in temperature, on the other hand, gives rise to a depression, even to one of those profound abysses of the ocean aptly named 'deeps.' The cause of these secular variations in temperature, however, is not set forth, although in the mind of the author it seems to be in some way connected with chemical changes taking place in

a solid globe. The very high specific gravity of the earth's interior as compared with that of the lithosphere, is believed by the author to be due to an increase in density of the materials composing the deeper parts of the earth's interior, due to pressure, and is not, according to him, to be attributed to a difference in character of these materials as is commonly supposed.

The great continental or epirogenic uplifts above referred to are not to be confused with the comparatively trivial expansions and contractions to which mountain building is due and which are dealt with by Mr. Mellard Reade in his 'Origin of Mountain Ranges,' as well as in part two of the present work. These latter are local and due to tangential 'creeps' in the lithosphere and surface rocks, which are accompanied by a lateral transfer of material from one place to another, and result from the uneven heating of great masses of sediment. The great continental movements result from alteration in volume of certain portions of the earth's crust, unaccompanied except to a minor extent by lateral movement.

These great movements, moreover, have a very important influence on the secular variation of sea level, since there can be no alteration in the contour of that portion of the surface which is covered by the ocean without a corresponding change of oceanic beach levels over the whole surface of the globe.

In the second part of the book, the author enters upon a description of the results of an experimental investigation into the forms developed in certain materials by heating and by compression. These are presented for the elucidation of the problem of the origin of mountain ranges, and represent a continuation of the results already set forth in the author's former volume on the subject. The materials employed in these experiments were varied in character. At first the action produced by alternately heating and cooling a lead plate, fixed about the edges in a solid framework, was investigated. Anticlinal folds, simple and overturned, were thus developed in the plate, which became thinner in portions of its area owing to the transferrence of lead to the site of the fold.

Subsequently a series of experiments were carried out on the effects of lateral compression on narrow plates of lead alternating with strips of calico and covered by pieces of board, so arranged as to leave a vacant space above the middle of the composite plate. On compression anticlinal folds of several types were developed.

Bars of soap were then compressed in a similar manner, but could not be made to bend, a fault with slickensided surfaces always developing. Alternate layers of damp sand and of sand mixed with coal dust were then tried, and again the material would not fold, but sheared, developing a double set of sharply defined overthrust faults. Layers of moist sand were then alternated with sheets of tea lead and submitted to compression in the same way. In this case the lead prevented the sand shearing, but developed a complicated series of overturned folds to which the sand accommodated itself.

A series of experiments were then carried out on the circular compression of disks of various materials, with the development of domed folds of many types, some of them showing spiral or screw-like movements, similar to those described by Mrs. Gordon in her paper on 'The Torsion Structure of the Dolomites.'

The third part of the book consists of 'Reprints, Speculations and Closing Remarks.'

Among the reprints are the author's well-known papers on the 'Denudation of the Two Americas,' 'The North Atlantic as a Geological Basin,' and a 'Theory of Slate Structure and Slaty Cleavage.' It also includes chapters on 'Time as a Geological Factor,' and on the bearing of the present investigations in the supposed permanence of ocean basins and continents, on which latter much-debated question the conclusion is reached that 'interchanges of such magnitude have occurred in the distribution of the oceans and land masses during geologic time that it would be a misnomer to call them permanent.'

The book, while containing many interesting observations and embodying much research, would be improved by a more careful elaboration of the material which it contains,

in its present form its various parts showing a certain lack of unity. It is well printed and elaborately illustrated.

Frank D. Adams.
McGill University, Montreal.

Catalogue of the Crosby Brown Collection of Musicians' Portraits. Biographical Sketches. New York, The Metropolitan Museum of Art. 1904. 8vo. Pp. vii + 131.

In the series of handbooks relating to Mrs. Brown's great collection which have received notice in Science as they have appeared this little volume is part IV. Along with musical instruments she has collected many hundred portraits of musicians; over 400 of these have been mounted, approximately in chronological order, on hinged frames, and placed in the exhibition galleries.

This catalogue gives a sketch of the life and works of the musicians whose portraits are exhibited, arranged in order of framing. It has also indexes, classified, geographical and alphabetical. It is noticeable that no American is found in the list and no living Englishman; this is doubtless largely due to the fact that photographs have been excluded except in one instance. In view of the many fine prints in the collection the addition of the names of artist and engraver would have added to the value of the work, and interested a wider circle of people in the collection.

The pamphlet does not call for extended review here; its special interest to readers of Science arises from the fact that it is a well-considered attempt to make a museum collection thoroughly intelligible to the public.

Charles K. Wead.

SCIENTIFIC JOURNALS AND ARTICLES.

The *Botanical Gazette* for July contains the following articles: W. J. Land has made an important contribution in the results of his study of "Spermatogenesis and oogenesis in *Ephedra trifurca*." Among the important results may be mentioned the occurrence of two persistent prothallial cells in the male gametophyte, no wall separating the second prothallial from the generative and tube nuclei; also the remarkable pollen chamber developed by the breaking down of the nucellar beak to the embryo sac, the necks of the archegonia projecting into the pollen chamber and coming immediately in contact with the pollen grains.—R. E. Smith presents 'The water-relation of *Puccinia asparagi*,' being a contribution to the biology of a parasitic fungus; both the direct and indirect results are discussed.—D. T. MacDougal presents a somewhat detailed account of 'Delta and desert vegetation' and shows that the region offers unusual opportunities for comparison of the most high developed xerophytic types of the desert with the broad-leaved forms of the delta which root in the mud.—J. C. Arthur has given an account of the discovery of 'The Aecidium of maize rust,' which is found on species of *Oxalis*. The communication is intended not only to announce an interesting fact, but also to illustrate a method of observation not yet commonly understood.—B. E. Livingston and G. H. Jensen have published a short statement of a somewhat striking result obtained from 'An experiment on the relation of soil physics to plant growth,' which gives somewhat conclusive evidence in favor of the view that the amount of water present in the surface layers of the soil is largely dependent upon the size of the soil particles.

DISCUSSION AND CORRESPONDENCE.

THE BIOLOGICAL SURVEY OF THE WATERS OF THE PACIFIC COAST.

To the Editor of Science: The biological survey of the waters of the Pacific adjacent to the coast of southern California recently inaugurated by the San Diego Marine Biological Association will be prosecuted continuously for a number of years. The laboratory connected with the survey, at present located at Coronado, is under the immediate charge of the resident naturalist, and is ready at all times of the year for occupancy by investigators.

The director is authorized by the managing board of the association to offer the privileges of the laboratory to biologists who may desire to visit this locality for a period in the prosecution of special researches. Such facilities

as the station possesses—which are not, as yet, extensive—will be gladly placed at the service of visiting naturalists without charge, but microscopes can not usually be supplied. It should be understood that at present the station is equipped and manned solely with reference to the survey. Any one who may contemplate accepting the invitation here extended should communicate with the Director at the University of California, Berkeley, California. The resident naturalist for the present year is Mr. B. M. Davis whose address is Point Loma, San Diego, California; and for special information relative to materials available for study at particular times, living facilities, etc., he should be communicated with.

The following are among the species of animals that may be had at any time, at certain seasons of the year, or by special efforts in collecting:

Ceratium, several species; *Thalassicolla* and other spumularia; *Acanthometron* and other Acantharia; several sponges, species undetermined; *Tubularia crocea, Corymorpha palma, Campanularia æstualis, Sertularia desmoides;* of medusæ: *Obelia* sp., *Pelagia* sp.; *Sphæronectes köllikeri; Renilla amythystina, Virgularia* sp., *Cerianthus* sp., *Edwardsia* sp., *Sagartia pedrensis, Epiactis prolifera, Anthopleura californica; Toxopneustres* sp., *Strongylocentrotus purpuratus, Lovenia cordformis, Echinarachnius excentricus, Asterias capitata, Asterina miniata, Phataria* sp.; *Ascopodaria* sp., *Bowerbankia* sp., *Crisia* sp., *Scrupocellaria* sp.; several opisthobranchs; *Bulla mebulosa, Monocerus* sp., *Cerostoma* sp., *Chiton conspicua, Pectin æquisulcatus* and *monotimeris, Octopus punctatus; Calanus finmarchicus, Eucalanus attenuatus, Acartia tonsa* and other species, *Oithona,* several species, *Phronima* sp., *Paraphronima* sp., *Euphausia splendens, Callianassa longmana, Alphius clamator* and other species, several hermit crabs; *Ciona intestinalis, Perophora* sp., *Pyrosoma atlanticum, Salpa runcinata-fusiformis, Cyclosalpa affinis, Doliolum tritonis, Oikopleura* sp., *Dolichoglossus pusillus, Tornaria ritteri; Branchiostoma californiense, Polistotrema stouti, Gyropleurodus francisci, Galeus californicus, Urolophus halleri, Fundulus parvipinnis, Typhlogobius californiensis.*

WM. E. RITTER,
Director.

CORONADO, CALIF.,
July 7, 1904.

PROFESSOR TAGUCHI'S BRAIN-WEIGHT.

TO THE EDITOR OF SCIENCE: In response to a further inquiry concerning the brain of the Japanese anatomist, K. Taguchi, the following communication was received from K. Yamagawa, president of the Imperial University of Tokio:

"In reply to your favor of May 9, 1904, I am sorry to say that the figure for the weight of brain in the last information, sent to you through Miss Gardener about the post-mortem examination of the late Professor Taguchi, was found to be wrong. It seems to me that the weight of his brain was put down as 1,920 instead of 1,520, which is the right figure, by mistake when it was copied from the original record. I apologize, etc.

K. YAMAGAWA."

The corrected figure places Taguchi's brain in the thirtieth place among those of men notable in the professions, arts and sciences, instead of second place, as first reported.

EDW. ANTHONY SPITZKA.

July 28, 1904.

SPECIAL ARTICLES.

VARIÆ AUCTORITATIS.

A PLEA for exactitude in citation of the older writers on natural history is, perhaps, less likely to be sustained than in the case of modern authors, on the ground of their being antiquated and of minor importance. Nevertheless, from an historical and esthetic standpoint, precision of reference is as desirable in the one case as in the other. It is of course less irksome and time-consuming to accept some standard authority in lieu of verifying original sources; but errors once introduced into general compilations are apt to persist indefinitely. Instances of the latter sort are to be found in nearly all compendiums of the

history of natural science, particularly those of geology and paleontology.

A few cases invite attention. One fresh at hand is furnished by Dr. S. F. Emmons's interesting address on 'Theories of Ore Deposition historically considered.'* It is remarked in one place that 'as early as Origines, 600 B. C., the observed occurrence in the rocks of casts of shells and plants was attributed to periodical floodings of the land.' Now there was one Origen, an illustrious Alexandrian theologian and founder of the science of the church; but of an Origines who lived in the fifth century B. C., history is silent. From the date assigned by Dr. Emmons it is probable that he intended to indicate Xenophanes, who commented on Sicilian fossils; or if he really had in mind one of the early Christian writers who mention them, the names of Pomponius Mela and Tertullian suggest themselves. But to make of Origen a plagiarist of Greek philosophy *malgré lui* is uncharitable, considering his defense of its study. Dr. Emmons also credits de Saussure with being the originator of the term geology. It was, however, proposed much earlier, Richard de Bury having introduced it as a special term, '*geologia,* or the *earthly* science,' in chapter xi. of his *Philobiblon,*† written one year before his death in 1345.

For another example one may refer to Dr. O. P. Hay's recent paper on Cretaceous fishes from Mt. Lebanon,‡ in which he quotes an English authority (Mr. J. W. Davis) as saying that these remains were first mentioned by Herodotus. But inquiry is made of the father of geography in vain for confirmation of this statement, though a passage indeed occurs in Book ii. relating to fossil shells of Africa. Apropos of Lebanon fishes, we notice that Dr. Hay's authority extracts an article from a Parisian newspaper relating to their discovery by the last of the Crusaders; but no mention is made of the famous chronicles of Saint-Louis, by Sire de Joinville, in which this narrative occurs.* That Voltaire was familiar with the latter can scarcely be doubted, and who knows whether it may not have been father to his sarcastic suggestion that fossils were probably nothing but the *disjectamenta* of pilgrims returning from the Holy Land?

But for the context, we might not be able to recognize under Professor Marsh's appellation of 'Albert the Great'† a celebrated scholastic philosopher of the thirteenth century, whose proper name was Albert von Bollstädt. Admirers of his learning accorded him the title of *Doctor Universalis,* envious ones called him the 'Ape of Aristotle,' though such contempt was unmerited. The name by which he is best known, Albertus Magnus, has been supposed to mean simply Albert the German. Dante refers to him, for instance (*Conv.* iii., v. 113), as 'Alberto della Magna,' la Magna—or l'Amagna—being Germany, whence also the modern Gallic equivalent. The patronymic of a well-known sixteenth century writer, George Bauer, or, in its more usual Latinized form, Agricola, has also been a source of some confusion. Even so careful a writer as L. F. Ward, for example, refers to him in his 'Sketch of Paleobotany' as Georgius Bauer Agricola.

An anachronism occurs in the statements of the last-named author, and also in those made by Marsh, Lyell and other historians of geology, regarding theories of continental subsidence attributed by them to Alexander ab Alexandro. A pre-Copernican writer, he was naturally a stranger to the heliocentric cosmogony, and it is not surprising that his 'Dies Geniales' is barren of speculations such as have been claimed for it, especially by Brocchi. It is also impossible to verify the latter's assertion that fossils are mentioned in Boccaccio's *Filocopo,* and the allusion to fossil plants

* *Bull. Geol. Soc. America,* Vol. XV. (1904), pp. 1–28.

† Mr. E. C. Thomas' translation is now accessible in the initial volume of the King's Classics (1903).

‡ *Amer. Nat.,* Vol. XXXVII. (1903), pp. 685–695; also *Bull. Amer. Museum Nat. Hist.,* Vol. XIX. (1903), pp. 395–452.

* 'Sayette' of de Joinville, the scene of King Louis' discovery, and where news of his mother's death reached him, is the old French name for Sidon.

† 'History and Methods of Paleontological Discovery' (1879), p. 7.

in 'l'Acerba,' by Cecco d'Ascoli, is of the vaguest description.

A curious misquotation occurs in the bibliography of the older literature contained in Agassiz's 'Poissons Fossiles,' where 'Les Observations sur l'histoire naturelle, sur la physique,' etc., 'an anonymous work in six volumes,' is credited to Gauthier. The title obviously refers to the journal conducted for twenty years under that name by the Abbé Rozier, and continued after 1794 as the *Journal de Physique*. The author of the alleged anonymous communication on Bolca fishes cited by Agassiz at the end of his bibliography was the celebrated geologist Albert Fortis, his correspondence with Testa having been collected and published in book form by Count Gazola in 1793 and 1794.

To devote attention to minor minutæ of this nature will no doubt be esteemed by many as 'time elaborately thrown away.' But it must be conceded that accuracy even in smaller matters possesses an intrinsic virtue, and is as well worth striving for as are the third and fourth decimal places in mathematics, *Cui bono* may not be translated into the parlance of ideal scholarship.

C. R. EASTMAN.

HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

BOTANICAL NOTES.

ECOLOGICAL PLANT STUDIES.

PROFESSOR ATKINSON has recently issued a pamphlet of sixty-seven pages giving the outlines of a course of twenty-one lectures on the relation of plants to environment, delivered in the Summer School of Cornell University in 1903 and 1904. Contrary to the views of some 'ecologists,' the professor devotes a good deal of time (nine lectures) to a study of the structure of plants, under such headings as the organization of the plant, plant tissues, types of stems, foliage-leaves, root, flower-shoot, pollination, fruit and distribution, before taking up ecology proper. Under the latter appear such titles as ecological factors, vegetation types, plant migration, plant formations, forest societies, etc. While these lectures are merely outlined, it is not difficult to see that we have here a rational and logical presentation of this much-abused and generally badly taught subject.

From Professor Clements we have in the table of contents of an ecological work by him, now in press, a similar outline of another phase of the subject. This work (which will cover about 300 pages) is to be devoted to research methods in ecology, treated under four heads or chapters: (1) foundations of ecology, (2) the habitat, (3) the plant formation and (4) experimental ecology. Under the first are discussed the need of and the essentials of a system in ecology; under the second, the factors (water content, humidity, light, temperature, wind, precipitation, air-pressure, soil, etc.) and their measurement by instruments. The third chapter deals with the methods of research; the quadrat, transect, migration circle, photography, cartography and herbaria. In the fourth chapter, devoted to experimental ecology, the purpose and the scope are set forth, followed by a discussion of methods of field experiment, control experiments, comparative morphology and competition cultures. A book of this kind should go far towards correcting the looseness which has characterized too much of the work in ecology. It is to be brought out by the botanical seminar of the University of Nebraska.

ANIMALS IN THE PLANT KINGDOM.

No doubt many a botanist has felt that quite too many animal-like organisms have been included in the plant kingdom in recent years. The slime molds were originally included upon their superficial resemblance to the puff-balls, at a time when anything like a critical study of the biology of the organisms was unknown. De Bary long ago placed the slime molds 'outside the limits of the vegetable kingdom,' yet they are persistently retained in botanical manuals, and systems of plants. Thus they still hold their place in Engler's 'Syllabus der Pflanzenfamilien' in spite of his statement—'kein Anschluss an höhere Pflanzen.' Scientific consistency certainly demands their removal from the plant system. With them, also, should be cast out some much more recent animal intruders—the

Flagellatæ, Dinoflagellatæ and the *Silicoflagellatæ*, which never had any good right to be included among plants. These are the things which are happily characterized by Dr. Thaxter in a recent article in the *Botanical Gazette*, as 'a menagerie of organisms whose zoology is orthodox to a degree.'

Why the botanists should be bothered with all these 'beasts' (as Dr. Gray would have called them) is a puzzle which has not yet been satisfactorily solved. Whether the purging of the membership of the plant kingdom should go further and result in the expulsion of *Volvox* and its near allies is difficult to decide. In everything but its color *Volvox* is an animal—and a very good one at that—but whether its assumption of its green coat is sufficient to hide its essentially animal nature in other respects is, perhaps, open to argument, especially since it is such a pretty and interesting organism for laboratory demonstrations. While we should like to retain it, we are compelled to say that in all probability it is to be relegated to Dr. Gray's domain of 'beasts.'

A FLORA OF PENNSYLVANIA.

Nearly seventy years ago Dr. Thomas C. Porter began the collection and study of the plants of Pennsylvania, and until his death in 1901 he continued the work practically without interruption. At his death his manuscript was found to be essentially completed, needing only the editorial supervision of some one familiar with his ideas. Such an editor was found in Dr. J. K. Small, of the New York Botanical Garden, under whose direction the 'Flora of Pennsylvania' was brought out by Ginn, the Boston publisher. It is a synoptical flora, all descriptions of orders, families, genera and species being included in carefully made keys. Especial attention is given to habitat and distribution, and in this particular this is one of the most satisfactory floras ever published in this country.

The book contains about three hundred pages, exclusive of the very full indexes. It deals with the spermatophytes only, the ferns not being included, so that the word 'flora' is strictly proper as applied to the book. It includes 2,201 species, representing 655 genera, 156 families and 43 orders. It is a great and enduring monument to the industry and ability of the author.

Charles E. Bessey.
University of Nebraska.

*AGRICULTURE IN JAPAN.**

Only 14,995,272 acres, or 15.7 per cent. of the whole area of Japan, exclusive of Formosa, consists of arable land, and 55 per cent. of the agricultural families cultivate less than 2 acres each; 30 per cent. cultivate 2 acres or more up to 1½ cho, or a little less than 3¾ acres, leaving 15 per cent. of the farmers who cultivate farms of 3¾ acres or more. A comparison of the whole area under cultivation with the number of farm workers shows that, on an average, one man cares for a little less than an acre.

The government has attempted to aid the progress of agriculture by laws respecting irrigation, the protection of forests so as to control the flow of rivers in the interest of the farmer, the formation of farmers' guilds, the rearrangement of farm boundaries, and the improvement of drainage systems. Small as the farms are, their parts are usually separated so that a farm of 2 acres may consist of several nonadjacent lots, the average size of a lot being about one eighth of an acre. A law which went into force in 1900 provides for the rearrangement of boundaries by farmers exchanging fields for those owned by others so as to make the farms more compact and enlarge the fields to permit the use of horses and machinery, at the same time increasing the tillable area by straightening some boundaries and removing others. About 20,000 acres have already come under the operation of this law.

For the purpose of further promoting agricultural interests the government maintains a State experimental farm and nine branch farms. The work at these farms is largely theoretical, and is divided into eight departments, viz., seed, saplings, agricultural chem-

* Consular report from United States Consul-General Bellows, Yokohama, Japan.

istry, entomology, vegetable physiology, tobacco, horticulture, and general affairs. The results of the investigations are submitted to thirty-eight experimental farms, created and carried on by the provinces with the help of a subsidy from the general government, and theories are here subjected to the test of practical application before general publication. Among the results already accomplished by this method are improvement in the quality and quantity of crops through more careful selection of seeds and better understanding of the varieties suited to the conditions in different localities; more efficient modes of destroying injurious insects; ability to minimize the injury from plant diseases, such as smut, mildew, pear cluster-cups, etc.; increased skill in the application of fertilizers, and the discovery of indigenous grasses suitable for meadows, all meadow grasses having formerly been imported.

The general government aids the local treasuries to maintain six local agricultural schools for the instruction of farmers' sons in the general principles of agriculture, surveying, veterinary science, and related subjects. The government also carries on an experimental tea farm, on which is a curing workshop; a laboratory for investigating the disease of cattle and poultry; a cattle-breeding pasture for improving the native breeds of cattle for meat and dairy purposes, and two horse-breeding pastures for promoting the introduction of better horses.

Efforts have been made to introduce sheep raising and swine raising, but with only partial success. It is claimed that the conditions of climate and food supply present no serious obstacle to the success of sheep farming, but the statistics of 1901 showed only 2,545 sheep in the country. Swine raising has succeeded better, but can not yet be spoken of as an established industry of much importance, the number of swine having remained in the vicinity of 200,000 for several years.

The principal agricultural products, named in the order of their acreage, are rice, rye, barley, wheat, beans, mulberries, sweet potatoes, millet, buckwheat, rape, red beans, Italian millet, tea, indigo leaves, potatoes, sorghum, tobacco leaves, cotton and hemp. The area devoted to rice cultivation constitutes a little more than two fifths of the total area of arable land. The greater part of the rice fields are in low-lying land, which can be easily flooded, but some upland rice is raised. Mulberry trees and tea plants are usually planted on land not suitable for more important crops, such as the slopes of hills, sandy dunes, and similar places. In the warmer parts of the Empire barley and rape are often raised as a second crop after rice has been harvested, but farther north the excess of moisture required for rice leaves the land too cold for another crop the same year.

Stock raising is still in its infancy in Japan, and is not likely to become an important industry, owing to the high price of land and the coarseness of the native grasses, most of which are not fit for food for cattle or horses. Oats and maize as foods for farm animals are practically unknown, and what passes for hay is a kind of straw, which is chopped fine before it is fed to horses. A little less than one sixth of the arable land consists of plains and pastures, and of this about two fifths belong to the state and the imperial household, the remainder being owned by private stock raisers, who raise stock principally for tillage and draft animals. The natives are not accustomed to the use of butter or milk, and do not usually like the taste of them, and their religious prejudices have hitherto prevented the general use of meat of any kind, although they now seem to be developing a taste for all these kinds of food.

Farmers do not engage in poultry raising to a sufficient extent to provide the eggs needed for home consumption, these being imported from China to the value of over $500,000 per year. Fruit raising, under the stimulus of government encouragement, has advanced considerably, but is not yet an important branch of farming in this country. Bee culture is engaged in to a limited extent, but the industry is still in a primitive condition.

THE URBAN AND RURAL POPULATION OF GREAT BRITAIN.

THE general report of the census of Great Britain of 1901 has recently been issued. In

commenting on this report the London *Times* says:

"Attention has been prominently directed, by the report of the Committee on Physical Deterioration, to what is there described as the 'urbanization' of the people; and hence few portions of the volume now issued will be of more general interest than those which set forth the extent to which this process is actually being carried on. We find, in the first place, that the population has decreased in the five English counties of Huntingdonshire, Nottinghamshire, Westmoreland, Oxfordshire and Herefordshire, and in the five Welsh counties of Montgomeryshire, Cardiganshire, Flintshire, Merionethshire and Brecknockshire; the decrease ranging from 7.04 per cent. in Huntingdonshire to 1.62 per cent. in Herefordshire; and from 5.08 per cent. in Montgomeryshire to 0.17 per cent. in Brecknockshire. In the remaining forty-five English and Welsh counties there was an increase of population, ranging from 45.11 per cent. in Middlesex to 0.003 per cent. in Cornwall; but the increase in Radnorshire, which was only apparent, and is said to have veiled a real decrease, was due to the presence in the county of a number of men who were temporarily engaged in the construction of waterworks for the Corporation of Birmingham. Particulars are given for 1,122 urban and for 664 rural districts, and it appears that the aggregate population of the former in 1901 was 25,058,355, and of the latter, constituting the remainder of the country, 7,469,488; so that the persons enumerated in urban were to those enumerated in rural districts as 335 to 100; the proportions in 1881 and in 1891, in the urban and rural districts as constituted at those periods, having been respectively 212 and 258 to 100. The increase in the proportion resident in urban districts is attributed partly to an actual growth of population within those districts as they existed in earlier census years and partly to the growth of the districts themselves through the absorption of areas which were previously rural. It was pointed out in 1891, and is still the case, that a considerable number of the urban districts, although technically urban, are distinctly rural in character, being in many cases small towns situated in the midst of agricultural areas on which they are dependent for their maintenance as business centers. At the recent census there were 215 urban districts with populations below 3,000, 211 with populations between 3,000 and 5,000, and 260 with populations between 5,000 and 10,000; and the report follows the example of its predecessor in stating the proportions between urban and rural dwellers from these three points of view. If we class with the rural districts all those urban districts with populations below 10,000, the aggregate population of the remaining urban areas numbered 21,959,998, the population of the same areas in 1891 having been 18,964,882, and the rate of increase in the decennium being 15.8 per cent. In the rural areas, with the added small urban districts, the population increased from 10,037,643 in 1891 to 10,567,845 in 1901, or an increase of 5.3 per cent. There are, nevertheless, many rural parts in which actual depopulation has occurred, and these are found in the rural and small urban districts of twenty-three counties; while, although there has been a small increase of population in rural areas in the aggregate, there has, nevertheless, been a very considerable drain on the natural growth of the population of these areas. A table is given showing that, in a rural population of nearly five and a half millions, the natural growth by excess of births over deaths was 565,253 in the ten years preceding the census of 1901, but that the actual increase of population was only 64,599, showing a loss by migration of 500,654, equal to 9.1 per cent. of the population of 1891."

THE CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND.

The Carnegie Trust for the universities of Scotland has made awards for the year 1904–5 of twenty-four scholarships, twelve fellowships and thirty-five special grants, the total value of which is somewhat more than $25,000. The fellows are as follows:

Physical.—(1) Dugald B. McQuistan, M.A., B.Sc., Glasgow.

Chemical.—(2) Charles E. Fawsitt, B.Sc., Edinburgh (second year); (3) James C. Irivine, B.Sc., D.Sc., St. Andrews (second year); (4) William Maitland, B.Sc., Aberdeen (second year).

Biological.—(5) John Cameron, M.B., Ch.B., Edinburgh (second year); (6) Francis H. A. Marshall, B.A., Cambridge, D.Sc., Edinburgh; (7) Henry J. Watt, M.A., Aberdeen.

Pathological.—(8) Carl H. Browning, M.B., Ch.B., Glasgow; (9) John C. G. Ledingham, M.A., B.Sc., M.B., Ch.B., Aberdeen; (10) S. A. K. Wilson, M.A., M.B., Ch.B., Edinburgh.

Historical.—(11) Richard Bell, M.A., B.D., Edinburgh; (12) Duncan MacKenzie, M.A., Edinburgh (second year).

Grants for research are made as follows:

Physical.—(1) George A. Carse, M.A., B.Sc., Edinburgh; (2) Professor MacGregor, Edinburgh University; (3) Thomas Oliver, B.Sc., Edinburgh; (4) William Peddie, B.Sc., lecturer in natural philosophy, Edinburgh University.

Chemical.—(5) Professor G. G. Henderson and Dr. Gray, Glasgow and West of Scotland Technical College (second year); (6) A. N. Meldrum, D.Sc., assistant in chemistry, Aberdeen University (second year).

Biological.—(7) James H. Ashworth, D.Sc., assistant in zoology, Edinburgh University (second year); (8) John Beard, D.Sc., lecturer in embryology and invertebrate zoology, Edinburgh University (second year); (9) Cyril Crossland, B.A., B.Sc., assistant in zoology, St. Andrews University; (10) Professor J. Cossar Ewart, M.D., Edinburgh University (second year); (11) Professor Paterson, West of Scotland Agricultural College, Glasgow; (12) John Rennie, D.Sc., assistant in zoology, Aberdeen University (second year); (13) William G. Smith, B.Sc., St. Andrews; (14) David Waterston, M.A., M.D., assistant in anatomy, Edinburgh University (second year); (15) John H. Wilson, D.Sc., St. Andrews (second year); (16) Professors R. Patrick Wright and A. N. M'Alpine, West of Scotland Agricultural College, Glasgow.

Anatomical.—(17) Edward B. Jamieson, M.B., Ch.B., demonstrator of anatomy, Edinburgh University.

Pharmacological.—(18) Professor R. Stockman, Glasgow University.

Pathological.—(19) James Kerr Love, M.D., Glasgow (second year); (20) Edwin Bramwell, M.B., F.R.C.P.E., Edinburgh; (21) Professor Carstairs C. Douglas, B.Sc., M.D., Anderson's College Medical School, Glasgow (second year); (22) Alexander H. Edwards, M.B., C.M., Edinburgh (second year); (23) Alexander Goodall, M.D., Edinburgh (second year); (24) J. M. Kirkness, M.B., Ch.B., Edinburgh; (25) Professor Robert Muir, M.D., Glasgow University (second year); (26) Peter Paterson, M.B., assistant in surgery, Glasgow University; (27) W. B. Inglis Pollock, M.B., Ch.B., Glasgow; (28) Benjamin P. Watson, M.B., Ch.B., Edinburgh; (29) John M. Bowie, M.D., Edinburgh; (30) James Scott, M.D., Edinburgh (second year); (31) Douglas Chalmers Watson, M.B., F.R.C.P.E., Edinburgh.

Historical.—(32) William Cramond, M.A., LL.D., Aberdeen (second year); (33) Professor W. M. Ramsay, M.A., D.C.L., LL.D., Litt.D., Aberdeen University (second year).

Economical.—(34) William R. Scott, M.A., D.Phil., lecturer in political economy, St. Andrews University.

Linguistic.—(35) Kenneth MacKenzie, M.A., Glasgow.

SCIENTIFIC NOTES AND NEWS.

DR. HERMANN KNAPP, emeritus professor of ophthalmology in Columbia University, has celebrated at Giessen the fiftieth anniversary of his doctorate, when the diploma was renewed.

ALBERT VON REINACH, the geologist of Frankfort on Maine, has been made an honorary doctor of philosophy by the University of Marburg.

PROFESSOR V. M. SPALDING has resigned the chair of botany in the University of Michigan. His address after October 15 will be Tucson, Arizona, where he will continue his work begun last year at the Desert Laboratory.

PROFESSOR W. H. PICKERING, of Harvard University, is at present at Mt. Lowe Observatory, California, continuing his observations on the moon.

DR. J. WESLEY HOFFMANN is here studying the cultivation of cotton on behalf of the British government.

PROFESSOR MELVILLE T. COOK, of the department of biology at De Pauw University of Indiana, has been made chief plant pathologist by the Cuban government.

DR. SIDNEY D. WILGUS, of New York City, has been appointed by the State Commission in Lunacy as chief examiner, under the law passed by the last legislature creating a state board of alienists.

Dr. George F. Shrady, who has been editor of the *Medical Record* since its establishment thirty-eight years ago, has retired and is succeeded by Dr. Thomas L. Stedman.

The Middlemore prize of the British Medical Association for the best original work on ophthalmology during the past two years has been awarded to Mr. J. H. Parsons.

The Academy of Sciences, Berlin, has made a number of subsidies including 2,300 Marks to Professor Adolf Engler for the continuation of his work, 'Das Pflanzenreich'; 1,020 Marks to Dr. Emil Warburg for his investigation on the specific heat of gases at high temperatures, and 1,000 Marks to Professor Walter Kaufmann for investigations on electrons.

Dr. Judson F. Clark, of the Bureau of Forestry and instructor in the New York State College of Forestry at the time of its discontinuance, has been appointed provincial forester of Ontario.

Dr. Hans Battermann, astronomer at the Berlin Observatory, has been made director of the observatory and professor of astronomy at Königsberg.

Captain Arthur Mostyn Field, R.N., has been selected for the appointment of hydrographer of the British navy on the retirement of Rear-Admiral Sir William J. L. Wharton, K.C.B., F.R.S.

A committee has been formed in Bourg to erect a monument in memory of the astronomer Jerome Lalande.

The British Medical Journal reminds us that July twentieth was the hundredth anniversary of the birth of Sir Richard Owen at Lancaster, where an inscription on a house in Thurnham Street records the place of his birth.

Dr. Franz Hilgendorf, curator in the Museum of Natural History of Berlin, died on July 6, at the age of sixty-four years.

By the will of the late Frances Skinner Willing, of Chicago, the Mark Skinner Library at Manchester, Vt., will receive $40,000 as an endowment fund.

There will be a civil service examination on September 7, to fill a vacancy in the position of laboratory assistant in pharmacology in the Bureau of Plant Industry, Department of Agriculture, at $750 per annum.

Representatives of the principal South American states met at Rio Janeiro from June 5 to 12, to consider measures of sanitary prophylaxis.

Seventy-four members of the British Institution of Electrical Engineers have signified their intention of attending the Electrical Congress at St. Louis. Among them are the president, R. J. Gray Esq., Professor John Perry and Dr. R. T. Glazebrook.

The American Neurological Association will hold its next annual meeting at St. Louis, on September 15, 16 and 17, 1904, under the presidency of Dr. James W. Putnam, of Boston.

Nature states that arrangements have been made which will make it unnecessary to close the Museum of Practical Geology, Jermyn Street, for a month in autumn as heretofore; the museum will therefore remain open to students and visitors daily.

The Ziegler relief expedition arrived at Vardo, Norway, on board the *Frithjof*, on July 3, on its return from the north. Owing to ice and fog it did not succeed in reaching the *America*, having on board the Ziegler-Fiala arctic expedition. The *Frithjof* will sail north again as soon as possible.

We learn from *Nature* that the following excursions have been arranged in connection with the Cambridge meeting of the British Association which opens on August 17:

Audley End and Saffron Walden.—Audley End House will be visited by permission of the Lord Howard de Walden; the church and museum in Saffron Walden form other items in the program.

Brandon and Didlington Hall.—The most attractive features of this excursion will be the flint knapping industry at Brandon, Lord Amherst's Egyptian collections, rare books and illuminated MSS. at Didlington Hall.

Cromer.—Mr. Clement Reid, F.R.S., has arranged an attractive itinerary for those interested in the geology of the Norfolk coast.

Dykes of Cambridge.—This excursion includes an inspection of the well-known Fleam Dyke and Devil's Ditch, under the guidance of Professor

Ridgeway; opportunity will also be afforded for botanizing on the dykes. By the invitation of Mr. Richard Marsh, trainer to H. M. the king, tea will be provided at Egerton House, Newmarket.

Ely.—A visit to the cathedral, a building of exceptional architectural interest, under the guidance of the dean, forms the most important feature of this excursion.

Wicken Fen and Upware.—Members will travel from Cambridge to Upware in steam launches. This excursion is likely to be of considerable interest to geologists, entomologists and botanists.

Hatfield and St. Albans.—A visit to Hatfield House, by permission of the Marquis of Salisbury, visits to St. Albans Abbey, the site of Verulam, the sites of the battlefields of St. Albans, and the orchid houses of Messrs. Sanders, form the chief attractions.

Lincoln.—The exceptional architectural and archeological features of Lincoln seemed to the committee sufficient justification for arranging an excursion to this city, in spite of its distance from Cambridge. The mayor of Lincoln invites members to tea in the Castle grounds.

Norwich.—The cathedral, the hospital of St. Giles, and St. Andrew's Hall are the most important buildings to be visited. Hospitality is offered by the mayor of Norwich, and by Mr. and Mrs. James Stuart.

Sandringham, Lynn and Castle Rising.—This excursion, which is likely to prove one of the most popular, includes visits to the Lynn churches, the castle and church at Castle Rising, also the grounds, kennels, stables and dairy at Sandringham. Tea will be provided by invitation of H. M. the king.

Wisbech.—The lord lieutenant of Cambridgeshire has kindly invited members of the association to visit the old-world town of Wisbech, and facilities will also be afforded for inspecting the woad works.

ACCORDING to *Nature* the new hall of the Royal Horticultural Society in Vincent Square, Westminster, was opened on July 22. The building, which includes a library, offices, council chambers, and a lecture room, in addition to the large hall in which the society will hold its fortnightly exhibitions, has been built to celebrate the centenary of the society. In the address which Sir Trevor Lawrence read to the King and Queen the work of the Royal Horticultural Society was reviewed, and in regard to the efforts of the collectors sent out by the society in the nineteenth century, it was said, in the words of Mr. Andrew Murray, that "the results have affected the appearance of all England. Nowhere can a day's ride now be taken where the landscape is not beautified by some of the introductions of the Royal Horticultural Society." Perhaps nothing indicates more clearly the way in which the society has promoted the science and art of horticulture than the fact that whereas there were one thousand three hundred fellows in 1887, there are now eight thousand, one hundred and fifty. Baron Sir Henry Schroeder presented the report of the building and appeal committees, in which it was stated that twenty-six thousand pounds had been subscribed towards the cost of the hall, which will amount in the end to forty thousand pounds. It is the intention of the society to provide scientific instruction as well as practical training in connection with the gardens at Wisley.

WE learn from *Forestry and Irrigation* that a new classification of technical grades in the Bureau of Forestry went into effect July 1. This change was made in order to provide a set of generic titles that would tell more clearly what its men are doing. The titles are more easily distinguished, are more dignified, and mean more to the men themselves. The new grades with the yearly salaries they carry are:

Forester, $3,500.

Associate Forester, $2,700 to $3,000.—Chief of the ranking division and assistant to the Forester.

Assistant Forester, $2,100 to $2,600.—Chiefs of divisions and men occupying positions of similar responsibility.

Forest Inspector, $1,800 to $2,000.—Chiefs of the ranking sections of divisions and men in charge of independent lines of work of similar importance.

Assistant Forest Inspector, $1,500 to $1,700.—Chiefs of sections of divisions, except of the ranking section, and men occupying positions of similar responsibility.

Forest Assistant, $900 to $1,400.—Men who enter the Bureau through the examination for Forest Assistant and have not yet been given charge of independent lines of work.

Forest Agent, $700 to $900.—Men without civil-service standing, in charge of subordinate lines of work.

Forest Student, $300.—Men whose service is temporary and educational in character and whose training in forestry is incomplete.

Nature learns from the *Bulletin* of the Russian Society of Naturalists of St. Petersburg that the biological station which has been established near Alexandrovsk, on the Norman coast of the Kola peninsula, is now in working order. It is provided with all the necessary apparatus for pumping sea-water to a basin and an aquarium, as well as with a special sailing boat and all apparatus required for fishing and dragging.

On the occasion of the meeting of the British Medical Association, Oxford University conferred the degree of D.Sc. on a number of visiting physicians, including Professor William Osler, of the Johns Hopkins University. Professor Love, Sedlian professor of natural philosophy, presented the recipients, making remarks in Latin. According to the translation in *The British Medical Journal*, he said of Professor Osler: "Among those who apply the results of modern science to the investigation of the causes and the cure of diseases, few have attained greater distinction than William Osler. By his professional teaching, first in Montreal and afterwards in Baltimore, by his writings, which deal partly with questions of abstract science and partly with questions concerning the practise of medicine, by his skill as a physician, he has been for many years a leading exponent of the principle that the art of medicine should be based upon the most exact scientific knowledge of the day. For his work in exemplifying this principle, as well as for the merit of his contributions to science, he was elected a fellow of the Royal Society. In him also we welcome a representative of one of those daughter states which are the pride of the mother country—the Dominion of Canada—and also of that great republic of the west whose people, bound to us by the closest ties of kinship, are also among our best friends."

UNIVERSITY AND EDUCATIONAL NEWS.

The New York *Evening Post* states that the College of Physicians and Surgeons, Columbia University, has received a bequest of $10,000 by the will of Mrs. Eleanor Cooper.

Dr. Brown Ayres, professor of physics in Tulane University, has been elected president of the University of Tennessee.

Professor George M. Duncan has, according to the daily papers, resigned his professorship of philosophy at Yale University. Professor G. T. Ladd, it will be remembered, presented his resignation last spring, to take effect at the end of the next academic year. Professor Hershey E. Sneath, who has hitherto held the chair of ethics, has been transferred to the department of pedagogy.

Dr. Henry J. Prentiss, professor of practical anatomy, University and Bellevue Hospital Medical College, has accepted the chair of anatomy at the University of Iowa, made vacant by the death of Dr. J. W. Harriman.

Miss D. L. Bryant, S.B., of the department of geology, '91 of the Massachusetts Institute of Technology, received the degree of Doctor of Philosophy, June 30, 1904, at Erlangen, with the distinction of *magna cum laude*. After graduating from the institute she taught geology at Greensboro, N. C., and before leaving for Europe she took a course in petrography with Dr. Van Hise, at Madison, Wisconsin. She has since studied at Heidelberg, and for the past two years at Erlangen. Her graduating dissertation was upon 'The Petrography of Spitzbergen.'

Miss Marion Stopes, Ph.D., has been appointed junior professor of botany in the University of Manchester.

Dr. William Palmer Wynne has been elected professor of chemistry in University College, Sheffield.

Dr. L. Gerlach, professor of anatomy at Erlangen, has been made rector for the coming academic year.

Dr. Hippolyt Haas, professor of geology at Kiel, has retired from active service.

Professor L. Busse, of Königsberg, has been called to a professorship of philosophy at Münster, in succession to Professor E. Addickes, who has been appointed professor at Tübingen.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 19, 1904.

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DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

WE publish for the seventh year statistics in regard to the doctorates conferred by our universities. The degree of doctor of philosophy or of science was received by 281 candidates from 24 institutions. In addition to the 34 universities and colleges from which returns have been received, there may be a few cases in which the degree has been conferred legitimately by smaller institutions, but they are certainly very few. As a matter of fact, four fifths of all the degrees are conferred by seven universities. There have not during the past seven years, and probably never previously, been so many degrees conferred as in the present year. The numbers for the seven years are 234, 222, 239, 253, 216, 266 and 281. The figures fluctuate from year to year, but indicate an increase in seven years of about twenty per cent. This seems to be disappointingly small. In an article by Dr. Tombo, recently (July 15) printed in this journal, it is stated that the number of graduate students has more than doubled in the past five years, and in an article by Dr. Mayer, also printed here (July 8), it is said that the number of graduate students increased two and a half times from 1890 to 1902. It is not clear why the number who receive the advanced degree should not increase as rapidly as the number of graduate students. This is not due to a raising of the standards, as these have remained about stationary; nor is it due to lack of encouragement on the part of the universities, as fellowships and other in-

ducements are freely offered. Dr. Tombo states that Columbia has almost 700 resident candidates for the higher degrees, yet it conferred only 29 doctorates at the recent commencement. A large number of masters' degrees was conferred, but the men receiving this degree stop short of research.

TABLE I.

DOCTORATES CONFERRED.

	1898	1899	1900	1901	1902	1903	1904	Total
Yale	34	30	26	39	29	36	39	233
Chicago	36	24	37	36	27	32	36	228
Harvard	26	24	36	29	31	28	46	220
Johns Hopkins	33	38	33	30	17	23	31	205
Columbia	22	33	21	25	32	39	29	201
Pennsylvania	24	20	15	25	14	29	18	145
Cornell	19	7	19	21	23	20	13	122
Clark	12	5	9	7	1	4	10	48
Michigan	7	4	5	3	10	10	8	47
New York	5	9	7	6	4	4	9	44
Wisconsin	5	7	5	5	6	2	10	40
Virginia	0	2	2	8	6	3	1	22
Columbia	1	0	5	3	2	4	3	18
Minnesota	1	2	3	2	3	3	3	17
Brown	1	3	3	2	2	5	0	16
Bryn Mawr	3	3	1	2	2	0	5	16
California	1	3	2	2	1	3	3	15
Princeton	0	3	3	3	1	1	2	13
Boston	0	0	0	0	0	4	7	11
Stanford	2	0	2	2	2	1	1	10
Nebraska	2	1	1	1	0	0	2	7
Washington	0	2	0	1	0	1	1	5
Georgetown	0	0	0	0	0	3	1	4
Vanderbilt	0	0	3	1	0	0	0	4
Colorado	0	1	0	0	0	0	2	3
Kansas	0	1	0	0	0	2	0	3
Lafayette	0	0	0	0	0	3	0	3
North Carolina	0	0	0	0	2	1	0	3
Cincinnati	0	0	0	0	0	1	1	2
Iowa	0	0	0	0	0	2	0	2
Lehigh	0	0	0	0	0	2	0	2
Syracuse	0	1	0	0	1	0	0	2
Missouri	0	1	0	0	0	0	0	1
Tulane	0	0	1	0	0	0	0	1
	234	224	239	253	216	266	281	1713

The 1,713 men who have received the doctor's degree during the past seven years have not been selected by a severe process of elimination, but have in large measure been artificially encouraged. Probably not more than one in five of them will advance science or learning to a significant extent. Yet perhaps one half of all academic appointments are made from this small group. Science here suffers severely as compared with medicine or law, each of which professions receives some 5,000 recruits annually, allowing ample material for selection for the higher positions.

The first table gives details in regard to the universities which have conferred the degree during the past seven years. Harvard this year conferred 46 degrees, which is the largest number on the records. Yale, which like Harvard does not require the publication of the doctors' dissertations, still stands first in point of numbers, followed by Chicago, where the numbers are considerably augmented by degrees conferred on students of theology. A group of five universities conferred 181 out of 281 degrees. Wisconsin conferred 10 and Michigan 8 degrees; in view of the constant strengthening of the state universities and the large number of students from the central and western states who pursue graduate studies in the eastern institutions, we may expect a considerable increase in the number of degrees granted by the state universities. It is somewhat surprising that California and Stanford have together conferred the degree but twenty-five times in seven years.

TABLE II.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898	1899	1900	1901	1902	1903	1904	Total
Chemistry	27	32	26	28	26	33	33	205
Physics	11	7	15	23	12	14	17	99
Zoology	12	11	11	15	16	12	15	92
Psychology	18	15	9	13	8	16	10	89
Mathematics	11	13	11	18	8	7	13	81
Botany	11	11	12	8	11	9	17	79
Geology	6	5	5	10	6	10	7	49
Physiology	4	1	4	1	8	8	1	27
Astronomy	3	2	4	5	2	4	4	24
Education	0	5	8	2	1	2	0	18
Sociology	0	5	3	3	4	2	1	18
Paleontology	0	4	2	1	0	2	2	11
Bacteriology	0	1	1	1	1	3	3	10
Anthropology	2	0	2	1	0	1	2	8
Agriculture	0	0	0	0	2	2	2	6
Anatomy	0	0	0	1	0	4	0	5
Engineering	0	0	0	1	0	3	1	5
Mineralogy	0	2	0	0	1	1	0	4
Pathology	0	0	0	0	0	3	0	3
Meteorology	0	1	0	0	0	0	0	1
	105	115	113	131	106	136	128	834

The second table gives details in regard to the natural and exact sciences, in which

about one half of all the degrees are conferred. There is this year a falling-off in the relative number in the sciences, which is, however, not large enough to be significant. The larger institutions, in which half or more than half of the degrees were this year in the sciences, are Harvard, Johns Hopkins, Cornell, Pennsylvania, Clark and Michigan.

TABLE III.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898	1899	1900	1901	1902	1903	1904	Total
Johns Hopkins	19	17	20	19	9	10	17	111
Chicago	12	13	19	16	15	21	14	110
Columbia	10	23	12	13	14	18	11	101
Harvard	11	7	15	15	14	15	23	100
Yale	11	15	10	18	10	13	15	92
Cornell	11	2	11	13	16	13	8	74
Pennsylvania	8	8	6	12	5	14	9	62
Clark	12	5	9	7	1	4	10	48
Michigan	0	3	1	0	5	4	6	19
Wisconsin	2	4	1	3	4	0	4	18
California	1	3	1	2	1	3	2	13
Columbian	1	0	3	1	1	4	1	11
Bryn Mawr	1	2	1	2	1	0	2	9
Virginia	0	2	0	4	1	2	0	9
Brown	1	0	0	1	2	4	0	8
Stanford	2	0	0	1	2	1	1	7
Nebraska	2	1	1	1	0	0	1	6
Princeton	0	3	1	0	0	1	1	6
Minnesota	0	1	1	0	2	1	0	5
Washington	0	2	0	1	0	1	1	5
New York	1	1	0	1	0	0	1	4
Kansas	0	1	0	0	0	2	0	3
North Carolina	0	0	0	0	2	1	0	3
Lehigh	0	0	0	0	0	2	0	1
Vanderbilt	0	0	1	1	0	0	0	1
Colorado	0	1	0	0	0	0	0	1
Georgetown	0	0	0	0	0	0	1	1
Iowa	0	0	0	0	0	1	0	2
Lafayette	0	0	0	0	0	1	0	1
Missouri	0	1	0	0	0	0	0	2
Syracuse	0	0	0	0	1	0	0	1
	105	115	113	131	106	136	128	834

The third table gives details in regard to the separate sciences. There was an unusually large number of degrees with botany as the major subject. Otherwise there is no notable change in the positions of the subjects. The subjects in which three or more degrees were conferred by a university were: *Chemistry*—Yale, Pennsylvania, Columbia, Harvard and Johns Hopkins; *Physics*—Chicago, Johns Hopkins and Clark; *Zoology*—Harvard, Chicago and Johns Hopkins; *Botany*—Harvard and Wisconsin; *Mathematics*—Yale; *Psychology*—Clark.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses are as follows:

JOHNS HOPKINS UNIVERSITY.

James Barnes: I., 'On the Analysis of Bright Spectrum Lines'; II., 'On the Spectrum of Magnesium.'

Harry Preston Bassett: 'Determination of the Relative Velocities of the Ions of Silver Nitrate in Mixtures of the Alcohols and Water and on the Conductivity of Such Mixtures.'

Charles Edward Brooks: 'Orthic Curves; or Algebraic Curves which satisfy Laplace's Equation in Two Dimensions.'

Charles Geiger Carroll: 'A Study of the Conductivity of Certain Electrolytes in Water, Methyl and Ethyl Alcohols and Mixtures of these Solvents; the Relation between Conductivity and Viscosity.'

Walter Buckingham Carver: 'On the Cayley-Veronese Class of Configurations.'

Howard Waters Doughty: 'Phenylsulphone-orthocarbonic Acid and Related Compounds.'

Otto Charles Glaser: 'The Larva of *Fasciolaria tulipa* (var. *distans*).'

Elliot Snell Hall: I., 'A Study of Some New Semi-permeable Membranes'; II., 'Experiments on the Preparation of Porous Cups suitable for the Measurement of Osmotic Pressure.'

Henry Dickinson Hill: 'Measurement of Self-Inductance.'

Arthur Isaac Kendall: 'An Investigation of the Methods of Bacterial Technique, Preparation of Cultural Media, Cultural Characteristics and the Classification of Bacteria.'

Ernest Gale Martin: 'An Experimental Study of the Rhythmic Activity of Strips of Heart Muscle.'

John Joseph Rutledge: 'The Clinton Iron Ores of Stone Valley, Huntingdon County, Pennsylvania.'

Harry William Springsteen: 'The Magnetic Rotatory Dispersion of Sodium Vapor.'

Charles Kephart Swartz: 'The Columbus Formation of Central-Northern Ohio, including an Account of the Geology of the Eastern Part of Marblehead Peninsula.'

David Hilt Tennent: 'A Study of the Life-History of *Bucephalus haimeanus*, a Parasite of the Oyster.'

William Phillips Winter: 'An Investigation of Sodamide and of its Reaction-products with Phosphorus and with Phosphorous Pentachloride.'

Rheinart Parker Cowles: '*Phoronis Architecta:* Its Life-History, Anatomy and Breeding Habits.'

UNIVERSITY OF CHICAGO.

Thomas Eaton Doubt: 'The Effect of the Intensity upon the Velocity of Light.'

George Harrison Shull: 'A Second Contribution to the Establishment of Place-Constants for Aster Prenanthoides Muhl. at Clifton, Ohio.'

Elizabeth Kemper Adams: 'The Esthetic Experience: Its Meaning in a Functional Psychology.'

Jessie Blount Allen: 'The Psychology of the Guinea Pig.'

Raymond Foss Bacon: 'On Sodium Benzohydrol.'

William Henry Bussey: 'Generational Relations for the Abstract Group, simply Isomorphic with the Linear Fractional Group.'

William Harve Emmons: 'The Geology of Haystack Mountains, Montana.'

Fannie Cornelia Frisbie: 'The Effect of Pressure on Magnetic Induction.'

Thomas Carlyle Hebb: 'The Velocity of Sound.'

Arthur Constant Lunn: 'The Differential Equations of Dynamics.'

Charles Dwight Marsh: 'The Plankton of Lake Winnebago and Green Lake.'

John William Scott: 'Studies in the Experimental Embryology of some Marine Annelids.'

Laetitia Morris Snow: 'The Effect of External Agents on the Production of Root-hairs.'

Charles Zeleny: 'Studies in Regulation and Regeneration.'

COLUMBIA UNIVERSITY.

Hal Truman Beans: 'Maminobenzonitrile and Some of its Derivatives.'

Louis Israel Dublin: 'The History of the Germ Cells in *Pedicellina Americana*.'

Myron Samuel Falk: 'On the Elastic Properties of Cement Mixtures.'

Charles Savage Forbes: 'Geometry of Circles Orthogonal to a Given Sphere.'

William Flowers Hand: 'A Further Investigation of Syntheses of the Alkylketodihydroquinazolines.'

William Jones: 'Some Principles of Algonkin Word Formation.'

William Erskine Kellicott: 'The Development of the Vascular System of Ceratodus.'

Arthur Colon Neish: 'A New Separation of Thorium from Cerium, Lanthanum and Didynium by Means of Metanitro Benzoic Acid.'

Naomi Norsworthy: 'The Psychology of Mentally Deficient Children.'

Hervey Woodburn Shimer: 'The Upper Siluric and Lower Devonic Faunas of Trilobite Mountain, Orange Co., N. Y.'

William Cullen Uhlig: 'The Nitrogen Contents of Commercial Distilled Water.'

HARVARD UNIVERSITY.

Edwin Plimpton Adams: I., 'The Electromagnetic Effects of Moving Charged Spheres'; II., 'Water Radioactivity; III., 'The Induced Radioactivity Due to Radium.'

Glover Morrill Allen: 'The Heredity of Coat Color in Mice.'

Lewis Darwin Ames: 'An Arithmetic Treatment of Some Problems in Analysis Situs.'

James Carleton Bell: 'Reactions of the Crayfish to Sensory Stimuli.'

James Mackintosh Bell: 'Report on the Michipicoten Iron Range.'

Albert Francis Blakeslee: 'Sexual Reproduction in the Mucorineae.'

Foster Partridge Boswell: 'Visual Irradiation.'

Daniel Francis Calhane: I., 'The Action of Sodic Ethylate on Certain Dibromdinitrobenzols, with Some New Derivatives in this Class'; II., 'On the Manner of Oxidation to Quinones in the Case of Aromatic Diamines.'

Henry Avery Carlton: 'On Some Addition Compounds Derived from Certain Aromatic Compounds.'

Frederic Walton Carpenter: 'The Development of the Oculomotor Nerve, the Ciliary Ganglion, and the Abducent Nerve in the Chick.'

James Brown Dandeno: 'An Investigation of Some of the Effects of Water and of Certain Aqueous Solutions Applied to Foliage.'

Joseph Horace Faull: 'The Development of the Ascus and the Formation of the Spores in the Ascomycetes.'

John L. Hogg: 'Pressure Gauges for High Vacua.'

Arthur Becket Lamb: 'The Specific Heats of Aqueous Salt Solutions.'

Robert Greenleaf Leavitt: 'Trichomes of the Root in Vascular Cryptogams and Angiosperms.'

Philip Anderson Shaffer: 'An Investigation of Metabolism in the Insane, together with a Discussion of Analytical Technique in Metabolism Experiments.'

Grant Smith: 'On the Eyes of Certain Pulmonate Gastropods, with Special Reference to the Neurofibrillae in *Linax* Maximus.'

Philip Sidney Smith: 'The Copper Sulphide Deposits of Orange County, Vermont.'

Alfred Marston Tozzer: 'A Comparative Study of the Mayas and the Lacandones.'

David Hutton Webster: 'Primitive Social Control: A Study of Initiation Ceremonies and Secret Societies.'

Roger Clark Wells: 'The Atomic Weight of Sodium.'

James Jacob Wolfe: 'Cytological Studies on Nemalion.'

Henry Cook Boynton: 'An Investigation into the Relation between the Treatment, Structure and Properties of Steel.'

YALE UNIVERSITY.

Silas Palmer Beebe: 'The Effect of Alcohol and Alcoholic Fluids upon the Excretion of Uric Acid in Man.'

Howard Logan Bronson: 'On the Transverse Vibrations of Helical Springs.'

Robert William Curtis: 'The Action of the Halogen Acids upon Vanadic Acid.'

Edward Lewis Dodd: 'Multiple Sequences.'

Ralph Davis Gilbert: 'The Estimation of Vanadium.'

George Samuel Jamieson: 'Researches in Organic Chemistry.'

Oliver Clarence Lester: 'On the Oxygen Absorption Bands of the Solar Spectrum.'

Herbert Edwin Medway: 'The Use of a Rotating Cathode in the Electrolytic Determination of the Metals.'

Elbert William Rockwood: 'Studies in Nutrition.'

Burke Smith: 'On Surfaces which may be Deformed with Preservation of a Conjugate System of Curves.'

Clara Eliza Smith: 'Representation of an Arbitrary Function by Means of Bessel's Functions.'

Robert Eccles Swain: 'The Formation of Kynurenic Acid by the Animal Body.'

Mignon Talbot: 'Contributions to a Revision of the Helderbergian Fauna of New York.'

Andrew Lincoln Winton: 'Studies in Methods of Proximate Organic Analysis.'

George Albert Young: 'Geology and Petrology of Mount Yamaska, Province of Quebec.'

CORNELL UNIVERSITY.

Fred William Foxworthy: 'On the Histological Structure of the Wood of the North American Coniferæ.'

Oskar Augustus Johannsen: 'The Chironomidæ.'

Thomas Lyttleton Lyon: 'A Method for Improving the Quality of Wheat for Bread Making.'

Alexander Dyer MacGillivray: 'The Embryological Development of *Corydalis cornutus*.'

Arthur Renwick Middleton: 'The Determination of Acetylene.'

Clarence Lemuel Elisha Moore: 'On the Quadratic Spherical Complex.'

Walter Porter White: 'Spark Damping and Hertzian Waves of Small Damping.'

John Wesley Young: 'On the Group of Sign (0, 3; 2, 4, ∞) and the Functions belonging to it.'

UNIVERSITY OF PENNSYLVANIA.

Donald Sinclair Ashbrook: 'Electrolytic Separations Possible with a Rotating Anode.'

Lloyd Balderston, Jr.: 'An Interference Method for the Determination of the Speed of Sound in Liquids.'

Howard Winter Brubaker: 'Derivatives of Complex Inorganic Acids.'

Roy Dykes Hall: 'Observations on the Metallic Acids.'

Leslie Howard Ingham: 'The Use of a Rotating Anode in the Electrolytic Estimation of Zinc and of Nitric Acid.'

John Franklin Meyer: 'The Thermo-Electromotive Force of Nickel Nitrate in Organic Solvents.'

Sarah Pleis Miller: 'Determination and Separations of Gold in the Electrolytic Way.'

Ralph Emerson Myers: 'Results Obtained in Electro-Chemical Analysis by the Use of a Mercury Cathode.'

Everett Franklin Phillips: 'The Structure and Development of the Compound Eye of the Honey Bee.'

CLARK UNIVERSITY.

Charles E. Browne: 'Psychology of the Simple Arithmetical Processes.'

W. Fowler Bucke: 'Examinations and Grading.'

Edward Conradi: 'The Psychology and Pathology of Speech Development in the Child.'

Josiah Moses: 'Religious Pathology.'

August W. Trettien: 'Psychology of the Language Interest of Children.'

Fred Mutchler: 'A Study of the Structure and Biology of the Yeast Plant, *S. cerevisiae*.'

Jesse Nevin Gates: 'Cubic and Quartic Surfaces in 4-fold Space.'

Arthur L. Clark: 'Surface Tension at the Boundary Between a Liquid and the Vapor of another Liquid in the Neighborhood of the Critical Point.'

Joseph George Coffin: 'The Calculation and Construction of a Fundamental Standard of Self-induction.'

John Charles Hubbard: 'On the Conditions of Sparking at the Break of an Inductive Circuit.'

UNIVERSITY OF MICHIGAN.

Alphonso Morton Clover: 'A Study of the Peroxides of Organic Acids and the Hydrolysis of Organic Acid Peroxides and Peracids.'

Lewis Ralph Jones: 'The Cytolytic Enzyme produced by Bacillus Carotovorus and Certain Other Soft-rot Bacteria.'

Ward J. MacNeal: 'The Pathology of Experimental Nagana.'

Harriet Williams Bigelow: 'Determination of the Declinations of Certain North Polar Stars with the Meridian Circle.'

Edgar Nelson Transeau: 'The Bog Vegetation of the Huron River Valley.'

Frederick Amos Baldwin: 'On the Life History of Trypanosoma Lewisi and Trypanosoma Brucei.'

UNIVERSITY OF WISCONSIN.

Charles Elmer Allen: 'Nuclear and Cell Division in the Pollen Mother Cells of *Lilium canadense*.'

Rollin Henry Denniston: 'The Structure of Starch Grain.'

Susie Percival Nicholas: 'The Nature and Origin of the Binucleate Cells in Some *Basidiomycetes*.'

Fritz Wilhelm Woll: 'On the Relation of Food to the Production of Milk and Butter Fat by Dairy Cows.'

BRYN MAWR COLLEGE.

Virginia Ragsdale: 'On the Arrangement of the Real Branches of Plane Algebraic Curves.'

Marie Reimer: 'The Addition Reactions of Sulphinic Acid.'

UNIVERSITY OF CALIFORNIA.

William John Sharwood: 'A Study of the Double Cyanides of Zinc with Potassium and with Sodium.'

William John Sinclair: I., 'The Exploration of the Potter Creek Cave'; II., 'New Mammalia from the Quaternary Caves of California.'

COLUMBIAN UNIVERSITY.

Frank Van Vleck: 'Improvements in Ship Construction.'

LELAND STANFORD JUNIOR UNIVERSITY.

William Albert Manning: 'Studies on the Class of Primitive Substitution Groups.'

UNIVERSITY OF NEBRASKA.

Mrs. Edith Schwartz Clements: 'The Relation of Physical Factors to Leaf Structure.'

PRINCETON UNIVERSITY.

John Merrill Poor: 'Orbit of Comet 1900 II.'

WASHINGTON UNIVERSITY.

Samuel Monds Coulter: 'An Ecological Comparison of Some Typical Swamp Areas.'

NEW YORK UNIVERSITY.

Frederick G. Reynolds: 'The Viscosity Coefficient of Air and the Effect of the Roentgen Ray Thereon.'

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*SOME ASPECTS OF MEDICAL EDUCATION.**

THIS association has been, should be, and we trust will be the storm center of legislation for reform in medical education. Since the memorable editorials of Wood in the old *Philadelphia Times*, and the masterly papers and addresses of Pepper and the practical action of the University of Pennsylvania there has been virile progress. In most respects it seems definitely settled as to the course of education a candidate for the degree of medicine should take. Questions of pedagogy are still debatable, but we take it that that student who wishes the quickest returns, the most lasting remuneration, perennial stimulation of the intellect and continuous enjoyment in the pursuit of his labors, should take a college education of three or four years, a four years' course in medicine and, if possible, a hospital interneship.

Reference need only be made to the reports to this association, to the famous report of the majority committee of the Association of American Medical Colleges, to the numbers of the *Journal of the American Medical Association*, comprehensively devoted to education, and to many recent admirable addresses in support of the statements.

There is talk about maximum and minimum requirements, about laboratory and hospital courses, the merits of didactic

* Concluding part of president's address at the fifty-fifth annual session of the American Medical Association.

and clinical teaching—a mass of material brought forth from the viewpoint of the educator, or looking to the welfare of the medical profession. We do not minimize the value of such lines of discussion. It has brought us to the position we have attained. But what of the medical student? Should we not look at education from his point of view? Is he quite able to decide whether he should take up the profession of medicine? We hold that a great duty is due the aspirant for medical honors from teacher and practitioner. It is a kindness due him to point out the best methods of securing such education as will yield him results commensurate with the time and expense required. It would be a greater kindness to be enabled to show him that by reason of intellectual temperament or of physical or moral qualities he is not likely to reap the rewards he is anticipating.

The large majority of medical students do not have a good reason for studying medicine. They are ignorant of the mental and physical demands made on them. They are attracted by an uncertain glamor and a specious glory, and heedlessly they go in. The failure of a large percentage of graduates in medicine to acquire more than a bare existence, and too often not even that, proves that they were not educated properly, not fitted temperamentally nor physically, to pursue its duties. Should they not have opportunity for learning of the responsibilities and difficulties, rather than to have the brighter phases glorified? Would it not be well to have in our college curriculum a course of lectures for the student who contemplates entering a profession, pointing out the rocks and shoals in his prospective career? An eminent practitioner, not connected with medical schools, would light up and darken the pathway in due proportions. Then, too, should not, as in the army and navy, some physical tests be required? The trophy is to the robust, and sad will be the career of the man who is physically handicapped.

If there were any doubt about the value of a college degree to a man entering the medical profession it could be set at naught since the report of the Mosely Education Commission. Quotations like the following, while not pertaining to medicine alone, the result of extensive inquiry and mature deliberation, supported by the statistics they give, uphold the contention of a large employer, that 'for 99 per cent. of the non-university men, it is hopeless to expect to get to the top.' One opinion they express is that "there is still room for the boy of marked ability 'to come through,' but that his difficulties are greatly increasing, and that, useful as he is, his usefulness would have been greatly enhanced had he had the benefit of a college training." Still another commissioner reports that while only '1 per cent. of the entire population of America has received a higher education in her colleges and universities, this 1 per cent. holds more than 40 per cent. of all positions of confidence, of trust and of profit.' It is well known that the 'geist' of the individual brings success, for which they say "it is recognized that the educated man takes in a wide horizon and puts more 'soul' into his work."

The essential of success in any department is diagnosis, which requires powers of intellectual penetration and discrimination. President Thwing has again forcefully urged that 'reasoning of the mathematics—and mathematics is only reasoning—tends to promote *clearness* and *accuracy in perception, inevitableness in inference,* a sense of logical *orderliness.* The study of the languages represents the element of *interpretation.* The study of history means the interpretation of life.' Are these not the main studies of a college education? While they may promote scholarship, they surely cultivate thought. It

need scarcely be pointed out to this audience that to be a thinker is the salvation of the physician.

To the plea that the acquirement of a college degree takes up too much time and requires too much money, the material answer can be given from other sources to the effect that 'the men whom you are surprised to find holding such important positions in factories, though not much over thirty years, are the very men who did not leave the technical college till they were twenty-three or twenty-four; the graduate may have been twenty-five before he donned a jumper, but in five years he learned more with the college training he had as a foundation than the regular journeyman of fifteen years of actual work in the shop.' The experience of teachers who have watched the alumni agrees in that the college graduates get quick returns and soon acquire a position of independence.

The poor boy, therefore, need not be deterred, for if he has the spirit and energy to work his way through four years, two years or three years more will be but very little in the final summing up. If the student only knew that the purchase of the best education, whether reckoned in time or money, was the most economical investment, in that as to the former, a thorough education at first is time-saving in later years, and as to the latter, the money outlay is returned more quickly, in more immediate work and larger pay.

There should be one educational requirement—the equivalent of that for which a first-class college degree stands, whether received at a high school or university.

After entering the medical school with, it is presumed, the proper educational attainments, his career the first year should be closely watched. That school has too many students if it does not have enough instructors in the first year to be able to judge with a reasonable degree of accuracy of the character and moral stability of the men. This is not to be taken in a prudish sense or with too critical a scrutiny of habits which are the overflow of the animal spirits or the expiring exuberance of the boy approaching manhood. This can be said, that a student who does not play fair in his exercises, who cheats in one demonstration or evades another, who does not show manliness, frankness and truthfulness in his first-year duties, will not be a good diagnostician. He will cheat himself; he will cheat his patient. The teachers of the first year, or at least the second, should know this and block the student there and then. It would be a kindness. Let us then agitate whether we should not have a certificate of manliness, a certificate of health as well as a certificate of mental proficiency, before we admit students to our medical schools or permit them to go beyond the first year. Let us not be decoys, alluring them on to later destruction, but rather be guardians, wrapping the strong arm of experience about them to lead them to the fitting pathway.

Having permitted the student to pass further in his pursuits, we still owe him much. We must see to it that such course is given him the first two years of his student career that he will acquire such fondness for the science of medicine, such reverence for the exploration of its truths, that until his dying day devotion to it will be his stimulus and solace. As a corollary, we must insist that medical schools secure the best men in the market for these places and pay them salaries commensurate with their ability—good living salaries.

It is in the first and second years of his career that the foundations are laid whereby the student becomes the medical thinker. To quote again: "The power of thinking should not be of a base and barren character. The thinking should represent and be concerned with a fine and rich content of

knowledge. It should have the exactness of intellectual discrimination; it should have the fullness of noble scholarship; it should embody a culture which is at once emotional and esthetic and ethical, as well as intellectual."

That a desire to relieve suffering, to extend sympathy, to save life, is the impulse of the physician, we all admit, but where is the man among us who will not also admit that a scientific habit more quickly brings it about and more surely sustains and fortifies the humane instinct through the trials and tribulations of exacting practise? That prosecution of professional duties soon becomes commercial that does not have for its basis a true spirit of scientific inquiry. How miserable must that life be which conducts an exacting, drudging, daily routine with only material reward in view. Few are the practitioners who have this sordid view; we can be as sure medicine would soon be forsaken if this viewpoint alone were considered. Hence in the laboratory of the first two years must be aroused and fostered the stimulus for life-work.

The final years should be clinical years, and the last should be in a hospital. The medical school that allows its students to think such opportunity is not due them is most unfair to them. As our schools are now constituted, most of them can not give such requirements. The students should know, however, such requirement is necessary. What has been said regarding the preliminary college education applies equally forcefully to the hospital training. He is thrice armed who enters the arena thus equipped. Medical schools that can not give such education are cruelly unkind and unjust to the students by having them think it is not essential. Medical colleges that pass off a hospital training for one that is not truly such fake their students. The student who pays well for his training has the right to demand such as to fit him for immediate action.

It is not the fault of the medical school alone that he can not get it. The public that cries out when there is mistake in diagnosis, fault in treatment, and that shakes its head at the deficient education of our students, must share the blame with the medical school. The public admits that its individual members may at any moment almost be at the mercy of a half-educated physician. It is not necessary to recount, for it is well known, how on land or sea, by day or night, some event may arise in an individual life, the care of which may mean life or death. Even with this knowledge they withhold means to relieve themselves. They admit the necessity of a hospital training. But they, and particularly the public in control of hospitals not used for teaching, say each medical college should have its teaching hospital. They do not appreciate that to give an education which involves a hospital course would require an expenditure of $500 a year for four years by each student. It has been estimated that the cost of maintaining a plant and paying salaries sufficiently large to accommodate 600 students would require the above outlay by each student. Unfortunately, it is impossible to expect students to pay such figures, as it would render entrance into the profession almost prohibitive. It is manifestly impossible, as medical schools are constituted now, to educate all the students of the land properly. Hospital training can not be given except by a few favored institutions, because the doors of hospitals are closed either by the governing body of the hospital or by the teachers in the medical schools.

We believe, personally, if a decree should be issued that no medical school, including its hospital, should exist except on the fees derived from students, but little hardship would follow. The lessened supply of stu-

dents would increase the demands on the practitioner, so that larger returns would follow. The poor student would sacrifice and strive to get a degree, knowing then he had a good asset. A diminution in number and an increase in quality is demanded alike by the public and the profession. Such diminution in number would mean that the student would get back his investment quicker and in larger amount than at present, hence good men would be attracted. If we could abolish sentiment for sense and educate accordingly, there might be betterment all around. As it is now, medical students receive part of their education through the bounty of the state or the charity of the public, as such education can only be given in endowed institutions. The public is taxed so that the prospective physician can make a living. Is it right that it should be? Perhaps a mechanic should demand such right to make his son a good workman. We must all admit it is the duty of the state to educate the youth, so that good citizenship is maintained; we can question whether the state should educate the members to obtain a livelihood.

With the same indifference that the public views an epidemic's march they allow hospitals that are engaged in teaching to suffer for the want of funds. Moreover, they close their doors to the advent of teaching in the hospitals under their control. We must admit those who do not appreciate the true function of a hospital have some ground for their contention. Ruled by sentiment chiefly, unfortunately an impracticable master, they sympathize with the patient who still harbors the belief of old that the medical student is one of a class that prowl about not unlike harpies. The public does not realize the difference in the student of to-day and the student of tradition. We can not hold to account the governing body of the hospital who has the point of view that it is harmful to a sick person to have them under the surveillance of an alleged student rabble. We must admit some patients become alarmed, particularly in institutions where they know they will have the sympathy of the governing body. An analysis of motive will show that the usual patient who will not allow a judicious amount of clinical demonstration when the sense of delicacy is not offended, is truly selfish, in that there is prevented that increase of knowledge and development of skill whereby suffering of others may be alleviated. A little encouragement from the officials would allay alarm on the part of the patient. The desire to help others is infectious, and when one yields in a ward, others vie in the work.

The truth of the matter is that in hospitals in which teaching is carried on, rarely, if ever, do the patients complain. Indeed, it is the experience of those teaching institutions that judiciously conducted instruction is appreciated by the patient. In one hospital we might name most of the inmates are pay patients, giving $7 a week willingly, because they know they are buying the services of the best practitioners in the land—the teachers of medicine—which service they could not get at tenfold the figure. The fact that teaching hospitals are overcrowded, not by the poor alone, but by people independent of charity, shows that clinical instruction is not a bugbear. If the governing boards would know that while a few patients might be alarmed, on the whole most of them would be gratified by the attention paid them, and their sense of rectitude and manliness appealed to by the satisfaction that they are doing some good in enlightening students, so that others could be relieved; that their administration would be stimulated to do work beyond criticism; that the nurses would be aroused to better activity while under the observation of those not connected with the hospital; that the internes would do their

very best to have most complete studies of the case, and finally, that the chief in attendance, compelled to do his best at the risk of his reputation, they would gladly open their doors, even at the discomfort of the few, but to the advantage of the many. In short, the hospital should have teaching not to oblige the medical school, but for its own survival and regeneration. The benefits the student derives by the object lesson of an orderly hospital can not be estimated. Will not every member of a hospital board admit that his own character, his own sympathies, have been benefited by his connection with the hospital, even though, perhaps, he has not the advantage of an impressionable age? Can he not see, therefore, how the youthful student can be influenced in thought and character and feeling? He can not lightly toss aside this responsibility, nor even hide it by putting the onus of medical education on the teaching hospital. Every dollar endowing a non-teaching hospital robs the teaching hospital which is engaged in this larger duty.

It is true a class who are compelled to have hospital attention may not sympathize with this feeling. How can we obtain the confidence of this class? Let us organize such association of prominent people in our teaching centers who will agree to have any operation, any feature of disease witnessed by medical students, at the judgment of their attending physician. It would be well if the individuals of such an organization would agree, first, to undergo hospital treatment; second, to be the object of observation by students; third, to have an autopsy performed in case of untimely end. Such association would rob hospitals of their terror and teaching of its dread. No one can deny that on the whole the public would be benefited from whatsoever point of view we look at it. Indeed, the public ought to learn that disease is an enemy to themselves and their country. Just as we make sacrifices in time of national warfare, so we should be willing to make sacrifices in the daily battle for life. Just as aristocrat and plebeian, landlord and tenant, fight side by side in the former, so they should array in solid phalanx in the latter.

But there are hospitals willing to admit students, and yet the privilege is not availed of. This arises because the teaching force of the medical college is not willing to sink its personality and allow the student to go wheresoever he will for his instruction. Courage and some sacrifice is required perhaps. But, when one thinks of the mighty opportunity and the frightful waste, it is saddening. Every hospital should be a school. The fourth year should be so arranged that the student could avail himself of the advantages of hospitals in the immediate vicinity. Let each teaching body have the student understand what he must see and do, and trust you the true student will see it at the best place and with the best men. He must be accountable, of course, with a rigidity that means the exact acquirement of knowledge. To this end the first two years could be well spent in the properly equipped laboratory university, whether in town or country, the third in the authorized hospital of the school, the fourth in extramural hospital work.

Is it not anomalous that the hospital boards give to the nurses who are to act as aids to the physician the highest opportunities, and yet deny it to those who are to give orders to the nurses? This, of course, arises because training schools are the product of modern thought and have not been trammeled by tradition.

But all this talk of the primary education avails but little if we do not see to it ourselves that education is continuous; that from the day of our graduation, forwards, we do naught but toil, toil, toil. It should go without saying, as a mere business proposition, that unless we unceasingly

labor but little of the fruits do we pluck. It is demonstrated in a practical manner, for when we look about us and find the methods of those of our brethren whose labors are not in vain each one bears the scent of midnight oil.

The development of post-graduate schools, the growth of libraries, the groans of the printing press, the enthusiasm of medical societies, all testify to the spirit of persistent self-education that is abroad. It is not for me to urge further the importance of each of us taking from time to time months for study and reflection. Every active doctor should have his sabbatical year. We dare say, extended observations would uphold that in income a gain is one hundredfold for each dollar invested in educational outings, and for every hour thus employed, ten is added to life. To finance a medical man from first to last successfully, we dare say spend all net earnings of the first five years on self-education; 25 per cent. of each five years for further education; after ten years, 10 per cent. of the annual net earnings for an assistant, continuing the 25 per cent. investment each five years. Health, happiness, increased usefulness to the community —a success which never comes from eccentricity, equal to doubling capital every ten years, would follow. To this must be added the great mental satisfaction of a more clairvoyant vision in the prosecution of his daily duties, the inspiration that comes from the doing of things, the stimulation that arises from the solving of problems.

In the course of our work it is necessary for us to halt from time to time and review. Few of us are they who will not find as our days grow fuller an unconscious tendency to slight our work, to become slipshod, to hurry over matters. It is partly an evidence of overwork. The post-graduate school is the salvation. No obstacle can withstand the continuity of drill, which the earnest of us keep in action. If, to continue the imposition, asked what element of character is perhaps lacking to the greatest detriment to the profession and public, we possibly, one and all, would say courage. This is seen in the hesitancy which members of the profession show in giving an opinion, in advising an operation and in asking for an autopsy. How much confidence is destroyed by the want of free, frank avowal of the physician that he does not know on the one hand, or of clear, precise statement of his judgment concerning a case on the other! The greatest success in life is confidence. How many lives are lost by the worker in internal medicine not advising early and unequivocally an operation for fear he might be wrong in his diagnosis! And how many more are lost because the surgeon lacks courage to do, either because he fears the patient may die and his record be marred, or because he may operate when it is not necessary! We must admit we have had some operations done when they were not required, but let it be said to the credit of modern surgery, we have never seen an operation of such character performed by the right man that did any harm to the patient. On the other hand, the resort to operative procedures early, and in cases that even yet are not considered of surgical relief, has saved lives and lessened suffering to a degree that far overbalances the now and then futile measure. It may be assumed, without contradiction, that every case of bad appendicitis that happens to get well without surgical relief has in its wake three to five that die for the want of an operation. In other words, the pernicious influence of a surgical case that recovers without operation is evident in creating the hope that other cases demanding operation might get well without it.

And the man who does not want an autopsy—not only the centers of courage need

stimulation, but too often the entire medical storehouse needs refitting. Something, best known to the physician himself, we trust, is lacking in the one who treats an obscure case for a day, six days, six weeks, and then does not want an autopsy. If true to himself, true to the demands of his profession, courage will not fail him. In our mental and physical round-up, we must see to it that courage is given a new backbone from time to time.

But, fellow members of the association, not alone as members of this organization may we indulge in self-congratulation, but as members of a profession whose limitation knows no bounds, we may join in felicitation. Neither language, nor creed, nor country fetters our profession's munificent sway. The thoughts of Ehrlich in Frankfurt, of our own Welch or Councilman, of Kitasato in Japan, are correlated. The knife of Mayo in America, of Robson in London, of Kocher in Berne contributes to the relief of suffering in far Cathay. The founts of Lister's genius and Pasteur's divine inspiration bring countless blessings to England, to India, to France and to Africa. What a stimulus it is to realize that, howsoever small the contribution of the humblest of us may be, its impulse will be felt in climes near and far and ages present and remote! What awe can not but overtake us when we consider each heart throb we study entwines us to Harvey of two centuries ago; with every percussion tone reverberates the sound of Laennec's voice of a century; with each vaccine inoculation, the simple observation and reasoning of Jenner to stimulate our question and deductions!

We rejoice together and cherish our history, by the warp and woof of which we are woven to the past. What heritage for us and our children! Dead must be the soul that wearies of communion with the spirits of the past; deep must be its slumber on which falls the thought of centuries; lethargic its activities that are aroused not by the deeds of heroic men! "Honor and fortune exist to him who always recognizes the neighborhood of the great, always feels himself in the presence of high causes." We worship together our science, devotion to which brings forth character, smothers egotism, levels pretension, drives out solitude, develops such loftiness of thought which can see that 'against all appearances the nature of things works for truth and right forever.' Of our art, let us see to it that when the final summons comes it can be said of us, "Greater love hath no man than this, that a man lay down his life for his friends."

JOHN H. MUSSER.

PHILADELPHIA, PA.

NATHAN SMITH DAVIS.

IT is the sad duty of this academy to chronicle the death of its oldest member, one of its founders, who during the more active years of his life was one of its ardent workers. Dr. Nathan Smith Davis left this life on June 16, 1904. In his last illness he fully realized the coming change, which he foretold beautifully in one short sentence, 'I am going home.'

Dr. Davis lived a long, active and useful life. He was a man of supreme earnestness and seriousness; of great force of mind and strength of character; of high ideals and simple tastes.

His intense and lifelong sustained motive—or inspiration—to accomplish thoroughly the many useful ends to which he devoted his wonderful activity, left scarcely time for recreation. It left no time or thought for indulgence. His life was too full of purpose to lend much of its strength to self-gratification, nor was there much temptation in his well-ordered course. His chief pleasure was the satisfaction of useful accomplishment, and he found his

recreation in diversity of employment. Rarely, very rarely, do we see such subjugation of the material man to the higher attributes of his being. He led an ideal, normal life on a high moral and mental plane; as he ignored the pleasures of the flesh, so he was also superior to its discomforts, and endured its sufferings with fortitude through many years.

His lithe and vigorous body was the ready servant of his wonderfully well-coordinated mind and imperious will, and this with him meant much, for the demands he made upon his physical endurance were excessive.

His comprehensive and prophetic mental vision foresaw the needs of his profession, and of his community, and was a guide to his remarkable executive faculty. His qualities all combined to make him a pioneer among thinkers, and a general among organizers. It was through his semi-public deeds that he was most widely known—his great powers of mind found here their broadest opportunities, and it is through them that his memory will longest survive. The impress of his individuality was marked wherever his energy found outlet, and his rank was always among the leaders. But his memory's richest heritance is not bound with his triumphs; it lives in the homes of the thousands to whom he ministered in their sufferings, and who felt that in him they had a wise and loyal friend; and again, in the minds and hearts of his many students, whose ideals were shaped by his life and conduct. All who knew him best knew the spirit of kindness that ruled his heart. His private life was as unassuming as his public life was aggressive. Among his friends he was quiet, cordial, not very communicative, but spiced his conversation often with a tempered genial wit.

A brief review of his career will show the richness of his life. His primitive environment in youth and his limited opportunities in education throw his successes into strong relief, and accentuate the advantages to a man of an active, earnest mind, simple manners and upright ways.

He was born January 9, 1817, in Chenango County, N. Y., where his father had cleared ground for a farm. His first home was a log cabin, and his earliest realizations were the stern necessities in the struggle of subjugating the forest to man's needs.

His first sorrow was the loss of his mother when seven years of age.

From early youth his mind was bright, active and acquisitive. He attended the district school in winter months and at sixteen was given a year in the Cazanovia seminary. In 1834 he began the study of medicine under Dr. Daniel Clarke, of his native county. He shortly entered the College of Physicians and Surgeons of New York, and graduated January 31, 1837. In the meanwhile he had studied in the office of Dr. Thomas Jackson, of Binghamton. His graduating thesis was characteristic of him. Although still hardly more than a boy in years his selection of subject indicated breadth of understanding and his attitude towards existing opinion was bold and well taken. The subject was 'Animal Temperature,' and in it he took issue with the then existing authoritative view that the animal heat was developed within the lungs, and supported his arguments in refutation by recorded experiments.

In the following years he practised in Vienna, N. Y., and in Binghamton. In the latter town he married a daughter of the Hon. John Parker—the wife who survives him.

In these early years he found time, aside from his professional duties, to further prosecute his medical and surgical studies, and to broaden his field of knowledge in the allied sciences and economics. His mental activity soon gained him distinction. He wrote easily and freely, and several of his

medical articles won prizes. He was soon known throughout the state and became an active and prominent member of the state medical society.

In 1845 Dr. Davis was a prime mover and chairman of a committee to call a national convention of delegates from medical societies and medical schools of the different states to meet in New York. From this developed the American Medical Association, the National Medical Society of our country, in which he justly took great pride, and which in turn revered him as its founder and chief organizer and most hearty supporter.

Through his early work in this broad organization he became yet more widely known.

In 1847 he engaged in practice in New York city and, in his medical alma mater, began his long career as a teacher. Two years later he accepted the chair of physiology and general pathology in Rush Medical College of Chicago. In 1859 the medical department of Lind University—later the Chicago Medical College, and at present the medical department of Northwestern University—was organized with the express object of establishing a *graded course of medical instruction.* At that time no medical college in the country had a graded curriculum and the enterprise in hand was epoch-making. Dr. Davis was invited to take the chair corresponding to the one he held at Rush, which, after endeavoring in vain to persuade his colleagues to commit themselves to the graded system, he accepted, and took his seat in the faculty of the new college, where he remained until the time of his death. During many years he was the chief of the medical department and the dean of the faculty. During the last years of his life he retired from active service, but retained his connection with the school as emeritus dean and professor of the principles and practice of medicine and clinical medicine.

In supporting this new departure in medical teaching he followed his preconceived ideas. As early as 1843 he had earnestly advocated higher standards of professional qualifications for the practice of medicine in an address before the New York State Medical Society, and this opportunity to put his convictions into practice was eagerly seized, and the steady upbuilding of the new school was a vital part of his life work and that of his colleagues.

Dr. Davis's interests and activities were by no means confined to the field of medicine. He was one of the initiative factors of the Chicago Academy of Sciences, of the Chicago Historical Society, of the Illinois State Microscopical Society, of Northwestern University, and of the Union College of Law, of which faculty he was a member, filling the chair of medical jurisprudence. He was also one of the founders of the Illinois State Medical Society.

During all his life he was a warm friend and a strong supporter of the cause of temperance, and one of the founders of the Washington Home.

In addition to his many duties he was a prolific writer and contributed much with his pen to guide professional thought and mold public opinion. He was for many years editor of the *Northwestern Medical Journal.* He afterwards edited the *Journal of the American Medical Association* from 1883 to 1889, a task arduous in itself, but for which he found time amid the many other calls upon his strength and energies.

In 1887 he took an active part in preparing for the International Medical Congress to be held in Washington, D. C., and was at first secretary general and later president of the executive committee.

None except those with him at that time can realize the enormous amount of work entailed upon him by the many simultaneous duties in his various capacities of medi-

cal practitioner, medical teacher, editor of the *Journal of the American Medical Association* and secretary general of the executive committee of the International Medical Congress. During this severe strain he was stricken with complete right-sided paralysis, from which he fortunately soon recovered, but which left him with a slight weakness of the affected side. This illness, although so serious, was for him only an incident. With his returning strength he again took up his burdens and worked on with energy, patience and success. In this he exemplified his dominating characteristics. Whatever he did was done with all his might, and here we have the secret of his life: it was his strength of character, his physical and mental efficiency, his singleness of purpose, his transcendent altruism that made him a so potent factor in the development of so many of our useful institutions.

With the cessation of his works, and the extinction of the light of his life we have lost an active agent and an unwavering beacon in the upward trend to better things.

Frank S. Johnson.

SCIENTIFIC BOOKS.

Observations and Investigations made at the Blue Hill Meteorological Observatory, Massachusetts, U. S. A., in the Years 1901 and 1902, under the direction of A. Lawrence Rotch. Annals of the Astronomical Observatory of Harvard College, Vol. XLIII., Part III. 4to. 1903. Pp. 115–239. Pls. IV.

The Blue Hill volumes of the *Annals of the Harvard College Observatory* are always sure of a warm welcome at the hands of meteorologists, because of the importance and the high quality of the results which they contain. The present volume is no exception to this general rule. If there be any who do not know what meteorology owes to Mr. Rotch, such persons will find a simple statement of the reason for this great indebtedness in the following words, quoted from the introduction to the volume before us, which is signed by Mr. Rotch: 'All the expenses of the observatory continue to be paid by the undersigned, except the cost of publishing the investigations and observations.'

The introduction makes fitting mention of the death of Mr. A. E. Sweetland, the youngest member of the Blue Hill staff, whose name has already appeared in the columns of Science in connection with investigations carried on by him at the observatory. A fireproof addition to the observatory has been built, containing a library and a storage room for kites, and certain other much-needed additions to the older building have been made. It may be noted, in passing, that the total cost of these additions and alterations amounted to $7,000, and was paid by Mr. Rotch.

Besides maintaining the routine observations and automatic records at the summit and base stations, the chief investigation carried on at Blue Hill Observatory has been the exploration of the air by means of kites. The observations obtained by means of kites from August, 1894, to February, 1897, were published and discussed in Vol. XLII., Part I., Appendix B, of the *Annals of the Harvard College Observatory*. In the present volume the kite observations, together with the simultaneous ground observations, from March, 1897, to the close of the year 1902, are published in full (Appendix C, by H. H. Clayton), while the discussion of these observations, which is eagerly awaited, is reserved for a later volume. Since December, 1901, kite flights from Blue Hill have been made once a month, when possible, in cooperation with similar ascents of kites and balloons in Europe, carried out under the auspices of the International Committee for Scientific Aeronautics, of which committee Mr. Rotch is the American member. The results of the kite flights made from the deck of a steamer during a trip across the North Atlantic, reference to which has been made in these columns, are given in Table XIV. It will be remembered by readers of this journal that, as the result of his success in flying kites from the steamer on this trip, and previously from a tow-boat

in Massachusetts Bay, Mr. Rotch proposed an investigation by means of kites, flown from on board ship, of the meteorological conditions above the trades and the doldrums, a project which has received the approval of the International Aeronautical Congress, and of other scientific bodies.

The 'Effect of Meteorological Conditions upon Audibility' under various conditions at Blue Hill was observed during the year 1901, and the results are discussed by Mr. Rotch on pages 156–163. The source of sound was a steam whistle in the town of Hyde Park, the whistle being 4,400 meters northwest of and about 170 meters below the observatory. Investigations upon the electrification of, and upon the quantity of carbon dioxide contained in the air were conducted at the observatory by Mr. G. W. Pickard. Appendix D (pp. 215–239) is a discussion of 'Kites and Instruments Employed in the Exploration of the Air, at Blue Hill Observatory, 1897–1902,' by S. P. Fergusson, which will be found useful by any persons who are undertaking scientific kite construction. Of special interest are the sections which concern kite meteorographs, in devising and constructing which Mr. Fergusson has shown the greatest skill, ingenuity and patience.

Since Blue Hill Observatory first began its pioneer work in kite meteorology there has been a remarkably rapid development of similar work in Europe and elsewhere, but there is no reason to fear that the Blue Hill results will suffer in any way by comparison with those obtained abroad. R. DEC. W.

Vorlesungen ueber theoretische und physikalische Chemie, drittes Heft, Beziehungen zwischen Eigenschaften und Zusammensetzung. Second edition. By J. H. VAN'T HOFF. Braunschweig, Vieweg. 1903. 8vo. Pp. x + 155.

This is the third and concluding part of the second edition of Professor van't Hoff's 'Lectures.' Since the German, French and English versions of the first edition were noticed in SCIENCE, it is sufficient to say that in the present edition the subdivision and treatment of the subject are the same as in the first. There are a few verbal changes and some slight additions amounting to ten pages. The value of the book is immensely increased, however, by the fact that an index to the whole work has been furnished. The book is so familiar to chemists as a masterpiece of its kind that further commendation would be superfluous. ALEXANDER SMITH.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology and Psychology for July contains in addition to editorial and review matter, a paper of 67 pages by Miss Jessie Allen, entitled, 'The Association Process of the Guinea Pig, A Study of the Psychical Development of an Animal with a Nervous System well Medullated at Birth.' This research forms an excellent control to the similar one recently published by Dr. J. B. Watson on the white rat, the nervous system of which is entirely non-medullated at birth. The rat comes to psychical maturity at about the twenty-third day; the guinea pig, on the other hand, reaches psychical maturity on the third day, but even in the adult lacks almost entirely that ingenuity which is so characteristic of the rat's method of overcoming obstacles in order to reach food. Histological examination of the developing guinea pig's brain reveals differences from the developing rat's brain which can be closely correlated with the differences in psychical development.

A QUARTERLY journal entitled 'Opthalmology' will begin publication on October 1, with Dr. H. D. Wurdeman as editor and publisher. The associate editors include Drs. Chas. H. May, New York City; Casey A. Wood, Chicago; Chas. A. Oliver, Philadelphia; Blencowe E. Fryer, Kansas City; Albert B. Hale, Chicago; Edmond E. Blaauw, Buffalo; Chas. Zimmermann, Milwaukee; Dr. Wm. Zentmayer, Philadelphia; J. Guttman, New York City; and Frank Allport, Chicago.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF ST. LOUIS.

IN an earlier number of this journal, August 14, 1903, there appeared a brief notice of the organization of the Biological Society of St. Louis. Since that time a more formal

organization has been effected, and since the society has constantly increased in strength and importance it seems desirable to give a brief account of the scientific programs of all the meetings which have been held up to the present time.

At the first meeting of the society, held at the rooms of Professor Greeley, March 3, 1903, Dr. A. W. Greeley reviewed and discussed the work of Calkins upon the life-cycle of *Paramœcium caudatum*. The program of the second meeting, March 24, at the home of Professor Coulter, consisted of a discussion by Dr. J. M. Prather, of Loeb's investigations on and theories concerning the prolongation of life in unfertilized eggs and a review by Mr. J. Arthur Harris of the essential features of the mutation theory as elaborated by Professor De Vries. At the third meeting, with the society as the guests of Dr. Budgett, April 28, Dr. Oscar Riddle discussed the papers of Dr. Eigenmann on the eyes of the blind vertebrates of North America. Dr. Riddle had assisted Dr. Eigenmann in much of this work and in more yet to be published, and consequently the general discussion of the broad outlines of the problems involved and their relation to the whole perplexing question of degeneration were of especial interest. At this meeting, Mr. W. L. Eikenberry discussed the literature of the synthesis of carbohydrates in chlorophyll-bearing plants in the light of recent work on 'extra-organic' photosynthesis —a paper calling forth considerable discussion, because of the fundamental importance of work on enzymes. On June 2, the society was the guest of Mr. Eikenberry. Mr. J. B. Lillard reviewed Dr. Lillie's work on the refusion of blastomeres and an electrical explanation of mitosis, and Professor S. M. Coulter reviewed the treatise of Livingston on the rôle of diffusion and osmotic pressure in plants. The society adjourned for the summer months.

On September 26, the society convened at the residence of Dr. Budgett. The host presented a review and discussion of the recent work of Hardy on the behavior of protoplasm and artificial colloidal solutions. October 28, the society was the guest of Drs. Eycleshymer, Potter, Wilson and Ransom. An extensive business session in which several important points in the policy of the society were discussed and fixed, was followed by the scientific papers of the evening. Mr. Perley Spaulding reviewed Ewart's work on protoplasmic streaming in plants, and Dr. Peter Potter discussed his own work toward the establishment of a norm-plate of the human body. By new methods of hardening, it is possible to retain the organs in the position occupied during life while serial sections are made, and from measurements and tracings made from these, norm-charts may be prepared which illustrate with a high degree of accuracy the relative positions of the various organs. Numerous charts to serve as data for the completed work were exhibited. December 2, the society held its session at the residence of Mr. Drayer. Among other business matters, the report of a committee on membership, recommending that election of new members, duly proposed and recommended by sponsors at a previous meeting, should be by unanimous ballot of members present, was accepted. The scientific program consisted of three original papers. Dr. E. C. Eycleshymer exhibited and discussed the more important features of the plates so far prepared toward the norm-plates of *Necturus* on which he is working for Kiefel's 'Normaltafeln zur Entwickelungsgeschichte der Wirbeltiere.' Dr. J. Arthur Harris presented preliminarily the results obtained from a study of apically dehiscent anthers. It seems that there is a relation not only between this mode of dehiscence and the form of the anther and other floral parts as well, but between these and the geographical distribution of the genera and species in which it occurs. Professor S. M. Coulter discussed the establishment of the new biological station in the Bermudas and gave the results of his ecological reconnoissance of the islands. All of these papers will appear later. January 6, 1904, the meeting was held at Hotel Granville. Dr. G. H. Holferty presented his paper on the development and phylogeny of the archegonium of *Mnium cuspidatum*, which has since been published in the *Botanical Gazette*. Dr. A. W. Greeley discussed his work on the structure of proto-

plasm, giving the results of a continuation of the experiments described in a preliminary contribution to an earlier number of SCIENCE. This paper and a biographical sketch of its author by Dr. Lyon has appeared in the *Biological Bulletin* since the death of Dr. Greeley. January 27 the society again met at Hotel Granville. Dr. R. J. Terry discussed the results of his researches on the skull of *Necturus*, soon to appear in one of the German anatomical journals. The officers for the year were elected as follows:

President.—Dr. B. M. Bolton.
Vice-President.—Mr. H. C. Drayer.
Secretary.—Dr. J. Arthur Harris.

On the evening of February 26, the society was the guest of Dr. Bolton. Dr. W J McGee, chief of the department of anthropology at the Louisiana Purchase Exposition, presented the scientific paper of the evening, having selected for his theme some phases of the adaptations of desert faunas and floras to their environment. He first compared certain old world deserts, with their very scant plant and animal life, with those of the new, where organisms show a high degree of systematic differentiation, and attributed this to the more rapid development of desert conditions in certain old world areas. There the changes were too rapid to permit the evolution of an adaptive habit and structure while in the American desert conditions have permitted the evolution of special forms well adapted to environment. He briefly described and traced the development of the clumps of vegetation so characteristic of the American deserts and discussed the interdependence, seeming almost a symbolic relationship, between the different plant and animal species of which they are composed. Some remarkable cases of symbiosis were described and special emphasis was laid upon the origin and development of symbiotic relationship under the excessively severe life conditions presented by a desert and some suggestions made upon the importance of these conditions in human civilization. March 30 the society was the guest of Dr. Terry. The report of a committee appointed to draw up resolutions concerning the death of Dr. Greeley was received. The scientific papers of the evening were three. Dr. C. Fish reported upon his investigations of the nature of an antitrypsin, produced by immunization with pancreatic extracts. He could demonstrate that this antiamboceptor is thermstabile (60° C.) and combines with the haplophorous group of the trypsin. As to the latter positive proof could be brought, that its active form is the combination of the pancreatic proenzym with enterokinase, thus confirming the views of Pawlow and others. The enterokinase forms the complement. Mr. G. E. McClure spoke on the symbiotic relation between ants and certain plants, giving a general view of the subject and exhibiting illustrative material. The significance of such data as that furnished in this field in the solution of the much-vexed question of the origin of adaptations was extensively discussed. Dr. B. M. Bolton spoke on his already published work on the effect of certain metals and metallic salts upon the growth of bacteria and exhibited a large series of very interesting preparations. At the meeting of the society, held in the Central High School, April 27, Mr. F. A. Lucas, of the United States National Museum, presented an illustrated paper on the whale, discussing morphological, biological and economic questions concerning the different species and whale fisheries. The final meeting of the spring was held at the Cherokee Garden, May 25. Mr. J. F. Abbott spoke of his work on the highly interesting *Cœloplana*. Extended collecting during the course of two summers at Misaki, Japan, resulted in the securing of some thirty or more of Kowalusky's *Cœloplana*. No embryological material was obtainable, but by good luck in fixing, the histological details have been worked out and the morphological position of the form pretty definitely established. *Cœloplana* is without doubt a ctenophor derived from the Cydippida, that has abandoned a pelagic life and taken up a littoral habit with a corresponding change in body form and consistency, loss of costæ, reduction of otolith and great extension of the gastric canal system. Most of the essential ctenophoral characters, such as the grasping

tentacles, the adhesive cells, epithelial gland cells, ciliated rosettes, etc., have been retained unchanged. The ciliated rosettes, for example, must be looked upon as vestigial structures, in a form with so little parenchyma and such an extensive gastric canal system as *Cœloplana* possesses. And all the details of structure indicate a highly specialized form rather than a primitive one. *Ctenoplana* would seem to represent a midway stage in which the costæ have been reduced, but not entirely lost. Such a loss of an organ through disuse indicates merely specialization and adaptation to littoral conditions rather than degeneration. Hence Willey's contention that *Ctenoplana* is not 'degenerate' is unnecessary, and his hypothesis that the form is a primitive one, untenable. Dr. J. Arthur Harris spoke of recent experimental work in floral ecology, discussing the relative importance of color and odor in the attraction of insects as shown in the work of Plateau, Andreae and others. Professor Abbott was elected to membership—the first person to be elected to membership in the society—after which the society adjourned until the September meeting.

J. Arthur Harris,
Secretary.

AMERICAN FISHERIES SOCIETY.

The thirty-third annual meeting of the American Fisheries Society was held at Atlantic City, New Jersey, July 26–28. Seventy members, representing 26 states, were in attendance. About 50 new active members were elected, and 6 foreigners were made honorary members. The officers for this meeting were:

President.—Frank N. Clark, Michigan.

Vice-President.—Tarleton H. Bean, New York.

Recording Secretary.—George F. Peabody, Wisconsin.

Corresponding Secretary.—W. de C. Ravenel, Washington, D. C.

Treasurer.—C. W. Willard, Rhode Island.

The sessions were devoted largely to the presentation and discussion of papers, which covered a wide range of subjects. Among the noteworthy papers were the following:

Dr. Tarleton H. Bean: 'The Fish and Game Department of the Universal Exposition at St. Louis.'

Mr. W. E. Meehan: 'A Year's Work of the Fisheries Interest in Pennsylvania.'

Dr. H. F. Moore: 'An Account of Progress in Sponge Culture.'

Mr. Charles G. Atkins: 'The Utilization of Neglected Fishes.'

Dr. F. M. Johnson: 'A Western Charr in an Eastern Home.'

Mr. S. G. Worth: 'The Cultivation of the Striped Bass.'

Mr. John W. Titcomb presented some 'Fishery Reminiscences of South America,' and Dr. H. M. Smith gave a lecture on 'Japan, the Paramount Fishery Nation,' illustrated with lantern slides.

One session was devoted to a very interesting symposium on the black basses and their cultivation; and the carp question incidentally came up on several occasions.

Mr. George F. Peabody paid a feeling tribute to the late Hon. E. E. Bryant, president of the Wisconsin Fish Commission, who died while on his way home from the last meeting of the society at Woods Hole.

Near the close of the session, U. S. Fish Commissioner Bowers was called for and made some felicitous remarks.

Mr. Henry T. Root, president of the Rhode Island Commission of Inland Fisheries, was elected president of the society for the next term, and White Sulphur Springs, West Virginia, was selected as the place of meeting in 1905.

The society has about 450 active members, most of whom are engaged in practical or administrative work in fish culture or fishery protection, but some are biologists whose work brings them into touch with the fishery interests, others are commercial fishermen, and a few are simply anglers.

DISCUSSION AND CORRESPONDENCE.

AREAS IN THE UNITED STATES SUITABLE FOR BEET CULTURE.

To the Editor of Science: In the second part of Professor Armstrong's article, which appeared in Science, August 5, 1904, I note the statement made by him in regard to the preparation of a map showing the probable areas in the United States suitable for beet culture. In this connection it is only just

that reference should be made to the fact that the first map of this character published in the United States was constructed by Dr. Wm. McMurtrie and published in a special report, No. 28, of the U. S. Dept. of Agriculture in 1880. In Dr. McMurtrie's map the area of successful beet culture was indicated by a region contiguous to a line showing a temperature of 70° Fahrenheit during June, July and August and rainfall above two inches for the same months.

The remarkable success which attended the growth of sugar beets in the semi-arid regions of California in the early '80's led me to discard the factor of rainfall and to construct a map based upon temperature conditions alone, during the growing season. Some of the very best areas in the United States, suitable for beet culture are in arid and semi-arid regions. The idea, however, of mapping the beet areas in this country should be credited to Dr. McMurtrie.

H. W. WILEY.

JORDAN ON FOSSIL LABROID AND CHÆTODONT FISHES.

IN a recent paper on Eocene fishes from Monte Bolca, the present writer followed Dr. D. S. Jordan in his excellent 'Review of Labroid Fishes' (*Rept. U. S. Fish Comm.* for 1887 (1891), pp. 559–699) in uniting Cuvier's genus *Crenilabrus* with the earlier described *Symphodus* of Rafinesque. He also adopted the views of Agassiz and most recent authors in referring *Pygæus* to the Chætodonts. Since this paper was published,* the writer has received from President Jordan some valuable notes on the relations of the Eocene forms to existing genera, and as these are of extreme interest to students of both fossil and modern faunæ, advantage is here taken of his permission to make them available for others.

The following extracts may be considered as the most recent and authoritative opinion that has been pronounced upon the affinities of the forms in question.

DEAR DR. EASTMAN:

The following notes are at your disposal for any use you may care to make of them. I should now separate *Crenilabrus* C. & V. as a valid genus from *Symphodus* Raf. (= *Corious* C. & V.), with which I united it in 1891. *Symphodus* (*scina*) has the general characters of *Crenilabrus*, the serrated preopercle and other features, but it has the snout strongly produced, giving a concave profile, a matter probably worthy of generic distinction. *Crenilabrus* like *Symphodus* has 13 to 15 dorsal spines, and 31 to 33 vertebræ. I do not see how *C. szajnochæ* can be properly placed in it, as these numbers are fairly constant within the same genus. *C. szajnochæ* should form the type of a new genus.

Pygæus appears to be a generalized type, with traits ancestral to the Chætodonts, the Acanthuridæ, and to *Siganus* (*Amphacanthus*). It has the long and strong dorsal spines and the numerous anal spines of *Siganus*, as well as the few soft rays, large vertebræ and the general form of the body. The teeth are apparently much as in *Siganus*, and not brush-like as in the Chætodontidæ. The Siganidæ are scaleless, but in *Pygæus* the scales are small and prickle-like as in the Acanthuridæ and Zanclidæ.

The ventral fins in *Pygæus* seem normal (I., 5), but in *Siganus* the inner ray is also a strong spine, the formula being I., 4, I. In most Chætodonts there are but three anal spines, and no more in any of the Acanthuridæ. *Megaprotodon*, a genus of Chætodonts, has, however, four anal spines, and its form suggests resemblance to *Pygæus*.

Taking the somewhat minute differentiation of families accepted amongst recent fishes, *Pygæus* may be made the type of a family Pygæidæ, allied to *Siganus* on the one hand, and to *Megaprotodon* and *Zanclus* on the other; and, perhaps, related to the common ancestor of all these. * * *

After Gill I use the name '*Teuthis* L.' for *Teuthis hepatus*, for which Linnæus devised the name. This is equivalent to '*Acanthurus*' of most authors. Forskål's original *Acanthurus* (= *Monoceros*, = *Naseus*) has two hooks on the tail instead of a sharp spine, the ventrals being I., 3, instead of I., 5. *Acanthurus gaudryi* will probably turn out a new genus near *Teuthis*, but not quite the same. In our day *Teuthis* has nine dorsal spines and a movable caudal spine. *A. gaudryi* is nearer the Pacific genus *Zebrasoma*, which has three to five dorsal spines and the soft rays high. * * *

DAVID S. JORDAN.

It should be noted that Agassiz suggested the propriety of dividing *Pygæus* into two groups, *P. bolcanus* being taken as type of the one, and *P. coleanus* of the other. President

* *Bull. Museum Comp. Zool.*, Vol. XLVI., No. 1, June, 1904.

Jordan's remarks apply to the species resembling *P. bolcanus*. C. R. EASTMAN.

HARVARD UNIVERSITY,
CAMBRIDGE, MASS.

THE ASCENT OF WATER.

TO THE EDITOR OF SCIENCE: The identity between leaves and roots of trees which is signalized by the criticism in your last issue probably signifies that they have the same sort of resemblance as the entrance and exit of a building. But the critic can not be entirely ignorant of the recent researches which establish their antithetical relation so far as the contention of my paper is concerned. Near the leaves the ducts have an extreme vacuum, so long as transpiration from the leaf-surface continues; this vacuum diminishes downwards towards the base of the stem, as in a suction pump; and the inward current of water at the base is still dependent (when root-pressure is inactive) on a difference between the atmospheric pressure and the tension within the ducts. The results and authorities are summarized in Pfeffer's 'Physiology,' also in E. B. Copeland's paper in *Botanical Gazette* (October 19, 1902), and in Livingston's valuable book on 'The Rôle of Diffusion.' Whilst using these results my paper added nothing to them. Its only aim was to remove a stumbling block which was caused by the tortious assumption that atmospheric pressure can not lift water more than 1033 centimeters high. As the mixture of air and water within the ducts appears to be in the condition of foam, such pressure probably suffices to elevate it to the top of the loftiest trees. This is the part that ought to be criticized.

I am much obliged to the editor of SCIENCE for permitting me to submit the facts to his great constituency. And now I wish to withdraw from the case, and to leave its further consideration to others. G. MACLOSKIE.

PRINCETON UNIVERSITY,
August 8, 1904.

ANALYSIS OF A COMPLEX MUSICAL TONE.

THE analysis of a musical tone by means of Helmholtz's resonators makes a good lecture experiment when so carried out as to be heard by a large audience. Whether this has been accomplished by others I do not know, but I have succeeded as follows: A telephone receiver is connected to alternating current lighting mains (frequency 133 cycles per second) through a resistance sufficient to reduce the current to about $\frac{1}{8}$ ampere. The telephone then emits a tone having a fundamental pitch of 266 vibrations per second, and of which the overtones are prominent.

An adjusted resonator held over the mouth of the telephone strengthens the overtone to which it is tuned so as to make the overtone easily audible throughout a large room.

I have had no difficulty in demonstrating eight successive overtones in this way.

W. S. FRANKLIN.

SPECIAL ARTICLES.

THE EFFECT OF RADIUM RAYS ON THE COLON BACILLUS, THE DIPHTHERIA BACILLUS AND YEAST.

THE discovery that rays emitted from salts of radium may be used therapeutically in the treatment of some diseases, has opened an interesting field for conjecture as to the manner in which these rays act, and naturally suggests experiments concerning their effect on bacteria in general, and especially on specific microorganisms.

A few investigators have already published results of such experiments. Pfeiffer and Friedberger,* for example, found that typhoid fever bacilli were destroyed by exposure to the action of radium rays for forty-eight hours at a distance of about 1 cm., but not at 5 cm. distance. They found further that the bacteria only were affected, and that the culture medium remained unchanged. Anthrax spores dried on silk threads were destroyed after exposure for three periods of twenty-four hours each, but not after two twenty-four-hour exposures. G. Bohn† has also reported that 'lower organisms' are quickly destroyed by the action of radium rays.

* Pfeiffer, R., and Friedberger, E., 'Ueber die bakterientötende Wirkung der Radium-Strahlen,' *Berl. klin. Wochenschrift*, 1903, No. 28.

† Bohn, G., 'A propos de l'action toxique de l'emanation du radium,' *Soc. Biol.*, 55, p. 1655.

On the other hand Van Beuren and Zinsser,* as a result of a small number of experiments, were unable to ascribe with certainty any bactericidal properties to radium, and explained the few cases in which harmful action seemed to have resulted as due to the experimental error of the methods employed.

At the suggestion, and through the kindness, of Dr. Francis H. Williams, of Boston, who has employed radium in practice with marked success, I was recently enabled to make, under favorable conditions, some experiments to determine the effect, if any, of a brief exposure to radium rays of two well known species of bacteria (the common intestinal bacillus and the bacillus of diphtheria), and one blastomycetous fungus (yeast).

The radium salt used in my experiment was the pure bromide having an estimated radioactivity of 1,500,000 units. This salt emits three distinct sets of rays, known respectively as the alpha, the beta and the gamma rays. Of these the alpha rays are lacking in power and are readily absorbed by most substances, as, for example, by a mica plate, or a sheet of paper, so that they are without special interest in this connection. The beta rays are absorbed by certain substances, aluminium, for example, but if not cut off by these may be active at short distances, perhaps within five centimeters. The gamma rays are active at greater distances, even up to several meters, and are not readily absorbed. The number of gamma rays to beta rays is about one to fifteen.

It is easy to observe the combined action of the beta and gamma rays by exposing a culture of micro-organisms at a short distance from the radium, and the effect of gamma rays alone can be determined by interposing an aluminium screen of about one eighth inch in thickness. In my experiments the radium was enclosed in a metallic capsule closed on the upper side with a thin mica plate, and the whole was then covered by stretching over it a thin coat of rubber. Neither beta nor gamma rays were thus intercepted.

*Van Beuren, F., and Zinsser, H., 'Some Experiments with Radium on Bacteria,' *American Medicine*, December, 1903.

The first series of experiments was made upon the intestinal bacillus (*B. coli*), this being taken as a typical nonspore-forming organism, comparatively sensitive to environmental conditions. Active bacteria from streak cultures twenty-four to forty-eight hours old were inoculated into freshly poured agar plates. In some cases the organisms were spread out in thin surface films forming spots perhaps 5 cm. in diameter, while in other cases intersecting lines were drawn upon the surface of the agar with an infected needle. The plate cultures thus prepared were then exposed to the action of radium rays for different length of time, and at various short distances.

The radium capsule was fixed, mica-side uppermost, on a sterilized plate-glass table, and a plate culture, the cover having been removed, was inverted above it, and so placed that the infected area was exactly over and near the mica window. Protection from dust was secured by covering with a sterilized glass bell-jar. After the exposure the cultures were removed, their covers replaced, and the bacteria incubated for twelve to twenty-four hours at 37°. Control plates were made in every case, and the two sets were carefully examined, the general and microscopical appearance of the cultures, and the culture characteristics being noted.

Organism.	Distance from Radium.	Time of Exposure.	Result.
B. coli	2 cm.	20 min.	Negative. Growth not inhib.
" "	1 "	20 "	" " " "
" "	2 "	30 "	" " " "
" "	1 "	30 "	" " " "
" "	1 "	40 "	" " " "
" "	1 "	45 "	" " " "
" "	1 "	50 "	" " " "
" "	1 "	60 "	" " " "
" "	1 "	75 "	" " " "
" "	1 "	80 "	" " " "

At the outset brief exposures were made at distances of one and two centimeters. These having failed to show that the radium had any inhibitory or deleterious effect, the time of exposure was gradually increased in later experiments and the distance restricted to one centimeter or slightly less. Careful scrutiny failed to show that the radium had any harmful

action upon the bacteria. Details are given in the following table.

The action of radium rays upon the diphtheria bacillus (*B. diphtheriæ*) was next studied, the methods employed being the same as with *B. coli*. This organism was selected (1) because it may be regarded as a typical pathogenic microbe; and (2) because it has been suggested that radium, on account of its germicidal action, may be conveniently applied in the treatment of diphtheria. In such treatment the radium is to be encased in special tubes (to be obtained from dealers in radium) and these tubes inserted in the throat, whereupon, it has been claimed, the organisms will be destroyed. It has even been hinted that radium may replace antitoxin in medical practice.

Two cultures of *B. diphtheriæ* were experimented upon—one a laboratory culture of several generations since isolation, the other a recently isolated, virulent culture. As with *B. coli* the length of the exposure to the action of radium varied considerably, and in all cases the results were negative, as will be seen from the table.

Organism.	Distance from Radium.	Time of Exposure.	Result.
B. diphtheriæ	2 cm.	20 min.	Neg. Growth not inhib.
" "	1 "	20 "	" " " "
" "	2 "	30 "	" " " "
" "	1 "	30 "	" " " "
" "	1 "	40 "	" " " "
" "	1 "	50 "	" " " "
" "	1 "	60 "	" " " "
" "	1 "	70 "	" " " "
" "	1 "	80 "	" " " "

No experimental evidence whatever was obtained which would indicate that any degree of success can be hoped for in treating diphtheria by destroying the specific micro-organisms by means of radium rays.

A few experiments were also made to determine the action of radium on fungi other than bacteria, and for this purpose domesticated yeast (*Saccharomyces cerevisiæ*) was employed as a type of the blastomycetes. The method differed from that used with *B. coli* and *B. diphtheriæ* only in the fact that a wort-gelatine medium replaced nutrient agar, and that the plates were incubated at 25° instead of at 37°. As in the experiments with bacteria, negative results only were obtained, the most careful scrutiny failing to reveal any destruction, or even any inhibition, of the life or growth of the micro-organisms.

Organism.	Distance from Radium.	Time of Exposure.	Result.
Sac. cerevisiæ	1 cm.	20 min.	Neg. Growth not inhib.
" "	1 "	30 "	" " " "
" "	1 "	40 "	" " " "
" "	1 "	60 "	" " " "
" "	1 "	80 "	" " " "

These experiments and the conclusions to be drawn from them may be summarized by the following statements.

1. Radium rays have no effect upon fresh cultures of *B. coli*, *B. diphtheriæ*, or *Saccharomyces cerevisiæ* at a distance of one centimeter when the time of exposure is less than ninety minutes.

2. Any advantages derived from the therapeutic use of radium must be explained in some other way than by the direct weakening or destruction of the micro-organisms of disease.

3. The use of radium tubes in the treatment of diphtheria can not be recommended or regarded as a substitute for antitoxin.

In conclusion, I desire to express my obligation to Dr. F. H. Williams for the opportunity to carry on these experiments, and for many helpful suggestions.

S. C. Prescott.

The Biological Laboratories,
Mass. Inst. Technology,
July 30, 1904.

A WHEAT-RYE HYBRID.

To the Editor of Science: A few preliminary notes as to distribution of parental characters observed in the above type of hybrid grown by the writer during the present season may be interesting. The cross was obtained in May, 1903, by using a Russian variety of rye as the pollen- and Jones' Winter Fife as the seed-parent. No reciprocal crosses were attempted. Several seeds resulted, of which a few showed apparent xenia, the blue-gray color of the rye seed-coat being very evident

in the hybrid seed in some cases. Grown through the past winter and spring, and coming into maturity during July, it became apparent as the heads came out, that but one of the supposed hybrid plants was to exhibit rye characters in its gross morphology. This one, however, is most interesting. The general type of the head is that of the rye throughout, long, narrow and nodding. The spikelets have the elongate narrow form of rye spikelets, but lack the awns on the flowering glumes, which are, moreover, markedly pubescent like those of the wheat parent. The empty glumes are of the *Triticum* rather than the *Secale* type. In form of outline the anthers differ altogether from those of either parent. The leaves of the hybrid were free from the rust that affected the wheat parent. Four heads were produced by the hybrid plant, all of which were alike in type. Variance among the different heads borne on the same plant has been observed by the writer in the case of wheat variety-hybrids. But in this instance no such phenomenon was evident. Any observer would have recognized at a casual glance the extraordinary rye form in the entire group of hybrid heads. Material killed in Flemming's solution of the sporophyte vegetative structures and of stages in the development of the spores in the hybrid and of both of its parents, will be studied later, with respect to cytological details. It should be stated that attempts at crossing the rye again on the hybrid failed, and that none of the hybrid flowers became self-fertilized with one exception. The result, however, is a seed badly shriveled in the region of the embryo, and which does not promise germination.

H. F. ROBERTS.

KANSAS EXPERIMENT STATION,
MANHATTAN, KANSAS,
July 29, 1904.

NOTES ON INORGANIC CHEMISTRY.

THE MELTING POINT OF GOLD.

No little work has been done in recent years on the determination of the melting point of pure gold, as owing to the ease with which gold can be obtained in a very pure condition, this affords a valuable constant for high temperature work. In the latest experiments, which have been carried out by Jacquerod and Perrot and described in the *Comptes Rendus,* advantage has been taken of the fused quartz nitrogen thermometer, as owing to the small coefficient of silica, the correction for the expansion of the bulb is very small. The gold was heated in a special type of electrical resistance furnace, in which the temperature could be very accurately controlled, and the comparison with the thermometer was direct. The fusing point was found to be 1067.2° C. which is slightly higher than the 1061° determined by Callendar, Heycock and Neville, but lower than some other recent determinations.

FUSED SOAPSTONE FIBERS.

THE use of fused quartz was first brought to notice by Professor Boys, who found that quartz could be drawn into exceedingly fine fibers, which especially on account of their small elastic fatigue were superior to all other fibers for suspensions. From this beginning, by the labors of Professor Shenstone and others, the possibility of using fused quartz on a much larger scale has been realized, and now all the commoner forms of laboratory utensils can be made of this material. The chief advantages are the great resistance of quartz to most reagents, and its small coefficient of expansion. In a recent number of the *Physical Review,* Mr. K. E. Guthe shows that fused soapstone can be used to some extent like fused quartz. When heated in the gas-oxygen flame, it melts readily to a clear glass and can be drawn out into very fine fibers which have all the advantages of quartz fibers, and it is possible that other industrial uses may be found for it.

EXPLOSIONS FROM FERROSILICON.

LAST January two mysterious explosions took place at Liverpool in drums containing ferrosilicon. The cause of these explosions has been investigated by A. Dupré and M. B. Lloyd, and a paper dealing with the subject was read by them at the meeting of the Iron and Steel Institute. They consider that the probable cause of the explosions was the presence in the drums of water, which by its action upon the ferrosilicon occasioned the gen-

eration of silicon hydrids. These with the air in the drums formed an explosive mixture, which could be readily ignited by the friction between the lumps of ferrosilicon, or possibly by the presence of a phosphin which was spontaneously inflammable. Although these particular explosions were not very serious, the authors feel that attention should be called to the possibility of accidents of this kind in storing and shipping ferrosilicon, and make the suggestion that care should be taken that it always be kept dry and in a place where it will be well ventilated, thereby insuring against the possible accumulation of inflammable gases.

BESSEMER VS. OPEN-HEARTH.

At the same meeting Mr. F. J. R. Carulla made an appeal for the preservation of the Bessemer steel-industry. He described the manufacture of Bessemer rails in 1874 and held that the uniformity of the product then obtained left nothing to be desired. These requirements could and should be equally well fulfilled at the present day, and improvements should be made in the modern Bessemer process to enable this. This process ought not to be completely relegated to the rear by the development of the open-hearth furnace.

ROYAL SOCIETY CONVERSAZIONES.

The two conversaziones of the Royal Society held this year in May and June contained, from the descriptions in *Nature*, less than usual of interest to chemists. Naturally there were several exhibits in connection with radioactivity, the most interesting being an apparatus showing the spontaneous electrification of radium by Hon. R. J. Strutt. The radium salt in a glass tube is hung by an insulating support in an exhausted vessel. An electroscope is attached to the radium tube. Negatively electrified particles from the radium penetrate the glass tube which is covered with a conducting coating of phosphoric acid, so as to act as an inductor. Thus a positive charge is left and causes divergence. When the electroscope leaf touches the outer vessel, which is grounded, it collapses, and then begins to charge up again. This action goes on as long as the radium lasts.

Dr. Alan B. Green exhibited photographs illustrative of induced radioactivity of bacteria. Small masses of bacterial growth were exposed to the β and γ rays of radium bromid. Many of these masses when removed from the influence of the radium and placed between two thin plates of glass, were capable of affecting the photographic plate, even through a double layer of lead foil.

Mr. William Burton and Mr. Joseph Burton exhibited specimens of newly discovered crystalline glazes developed on English earthen and stoneware. These are artificial crystalline silicates, formed during the firing and cooling of the wares. In the 'sunstone' and 'fiery' glazes, the crystals show the optical properties of micas, in the starry and opalescent glazes the radiating needles are akin to the mineral willemite, as is shown both by their optical properties and chemical composition. The writer recalls that a year ago an American potter showed him a number of tiles with glazes similar to these last, with which he was then experimenting, hoping to produce them upon wares. They were remarkably beautiful, but it is not known whether they have yet been produced commercially, either in this country or in England.

NATURE OF SOLUTIONS.

Two important papers on solutions have recently appeared from Lobry de Bruyn in the *Recueil des Travaux Chimiques des Pays-Bas*. The first, in collaboration with L. K. Wolff, is on the possibility of detecting the presence of molecules in solutions by Tyndall's optical method. Spring has devised the method of rendering liquids optically clear, that is, showing no trace of a strong ray of light directed through them, by producing in them a precipitate of a colloidal hydroxid. This precipitate on settling carries down with it every solid particle which may have been suspended in the liquid. It was noted, however, by Spring that solutions of certain salts like alum and ferric chlorid could not be made optically clear and this was attributed to the formation of basic salts by hydrolytic dissociation. These basic salts form solid particles of ultra-microscopic size, which never-

theless are large enough to reflect and also to polarize light. These luminescent solutions are called pseudo-solutions. In true colloidal solutions the maximum diameter of the particles was found to be 5 $\mu\mu$, that is about ten times as large as the mean diameter of molecules. This raises the question as to whether there is any real boundary between true solutions and colloidal solutions. If not, substances with very large molecular weight ought to give evidence when in solution of interruption of a ray of light similar to that of colloidal solutions. It was found that water rendered optically clear was not affected by the addition of urea, acetamid, methyl or ethyl alcohol, but light reflected vertically from a solution of saccharose (mol. wt. 342) and raffinose (mol. wt. 504) was polarized. Strong luminescence was given by a solution of phosphomolybdic acid. The authors consider it probable that with sufficiently strong source of light even substances of lower molecular weight would show reflection from the dissolved molecules.

The second paper, whose co-author is R. P. Van Calcar, is on the effect of centrifugal force on dissolved substances. The solutions were submitted to a centrifugal force 400 times that of gravity. Under these conditions a one fifth normal solution of potassium iodid showed after three hours pure water in the upper portion, a concentration of 0.1 normal immediately below, 0.32 normal at the top of the lower half and one fourth normal at the bottom. In a number of other cases solutions became manifestly more concentrated at the periphery. In a solution containing 8.78 per cent. of sodium sulfate after five hours rotation a considerable amount of Glauber's salts, Na_2SO_4, $10H_2O$, had crystallized out and the remaining solution contained only 5.54 per cent. of sodium sulfate. These results are the more important, as it has generally been accepted since the negative experiments of Gay-Lussac, that the molecules in a true solution were unaffected by gravity, and hence were in a different state from those in colloidal or pseudo solutions, and it also confirms from a different point of view the results of Lobry de Bruyn and Wolff described above.

J. L. H.

SOCIAL AND ECONOMIC SCIENCE.

UNIVERSITY COMPETITION FOR GRADUATE STUDENTS.

IN his latest annual report President Hadley, of Yale, calls attention to this phase of university effort in the following statement: "For some time past many of the universities of the country have been engaged in a rather unfortunate competition for graduate students. There was in certain quarters a tendency to measure the success and usefulness of an institution by the numbers enrolled for graduate study. Under the influence of these ideas there has been a strong tendency to treat graduate students in the present generation as divinity students were treated a generation ago—giving them not only free tuition, but a great many other pecuniary inducements to pursue special studies for the degree of doctor of philosophy.

"This course of action involves an inversion of the true order of things. If you have real interest in science and literature you will probably have a number of men pursuing courses for the degree of doctor of philosophy; but it by no means follows that if you have a number of men pursuing courses for the doctorate of philosophy you will have a corresponding amount of interest in science and literature. On the contrary, this attempt to subsidize graduate students too often increases numbers at the expense of quality; and so far as it does this is bad. A good graduate student is about the best man that we have in the university; a poor graduate student is about the worst man. The same conditions which allow a man to rise above the average of his fellows if he has the ability and stimulus in himself allow him to fall below his fellows if he has not that ability and stimulus. * * * If the numbers of the graduate students increase instead of diminish it will be a source of congratulation; but it will be far better to submit to some loss of numbers than to continue a form of competition which is prejudicial to the quality of the students, wasteful of the resources of the university, and based upon an imperfect appreciation of the purposes and scope of university work. A uni-

versity exists for creating and maintaining standards, intellectual and moral. In order to have the highest intellectual standards, it must be a place where progressive thought is pursued and cultivated. But the number of men who claim to be occupied with the pursuit of progressive thought is no sure criterion of the degree to which the university is upholding such standards."

SERVICE OF SCIENCE IN SOCIAL WORK.

THE application of the laboratory method of training to the study of social subjects of vital importance to the community, especially to municipal communities, is well exemplified by the School of Philanthropy, conducted by the Charity Organization Society of New York City.

The Committee on Philanthropic Education, under whose auspices the summer school has been held in New York City for six weeks of each summer for the past six years, established last year a winter course, primarily intended for those who are engaged in practical social work, and who could give only a limited amount of time to lectures, class exercises and study. For this purpose the course was entirely successful, 159 students being registered, 121 eligible for, and 50 receiving, certificates.

It was later decided greatly to extend the scope of this course, and to offer a sufficient amount of instruction to justify those who enroll in it in devoting their entire time to it during the academic year.

Arrangements were made for extended courses of lectures on each of the more important branches of social work, such as: The care of families in their homes; the care of dependent children, both in institutions and by placing-out agencies; the care of the sick in hospitals, by dispensaries, by district nurses, etc.; state and municipal charities; reformatories, prisons and asylums; official inspection, sanitary and industrial; neighborhood work, civic improvement and educational advance.

The courses for the coming winter consist of from four to twelve lectures each, and include discussions by students, and opportunities for personal consultation with instructors. There will be, in addition, single lectures by eminent persons, dealing with particular institutions or problems upon which they are especially qualified to speak.

The enrollment will be limited to the following classes:

1. Men and women who have been engaged for one year or more in some form of philanthropic activity, as a profession, and who desire to improve their knowledge of the methods of social service.

2. College graduates who have taken at least one year's work in social economics or some kindred subject.

3. Senior students in theological seminaries or medical colleges who may wish, by special arrangement, to take one or more courses of lectures.

4. Others who satisfy the director by some indication of fitness, that they are likely to profit by the opportunities of the school.

One of the best services such enterprises render to society is the diffusion of the discoveries, often of a preventive character of course, of the various branches of natural science among the very people who are in most need of them. The distance between the scientific laboratory and the 'submerged tenth' is very great indeed; but the well-trained social worker does a very large share in bridging that distance and, therefore, in proving the value of science to the general welfare. The whole propaganda of sanitation depends on this process of enlightening popular sentiment to its own advantage, and thus increasing the economic efficiency of the less capable portion of the population.

VIRGINIA'S PROGRAM OF EDUCATIONAL PURPOSES.

THE Cooperative Education Commission of Virginia, which was organized last March, has formulated a policy under the title of a 'program of purposes' which have recently been made public. These purposes constitute a comprehensive scheme of objects in which it is desired that all the varied educational interests of the state should unite. They are as follows:

1. A nine months' school for every child.

2. A high school within reasonable distance of every child.

3. Well-trained teachers for all public schools.

4. Efficient supervision of schools.

5. The introduction of agricultural and industrial training into the schools.

6. The promotion of libraries and correlation of public libraries and public schools.

7. Schools for the defective and dependent classes.

8. The organization of a citizens' education association in every county and city.

9. Local taxation.

The commission as formed is said to be a thoroughly representative one. As may be inferred from the foregoing nine objects, it has for its purpose the unification of educational forces, with a view of utilizing their combined wisdom and strength in reenforcing the efforts of the state and local authorities in the matter of perfecting the public school system of Virginia. Such a movement as this is particularly promising on account of the hitherto independent development of educational institutions without that degree of correlation which would be advantageous to all.

A FUND of $30,000 has been secured through the efforts of Professor Richard T. Ely, of Wisconsin University, for the purpose of making an extended inquiry into the industrial history of the United States in its bearings upon the labor problems. The length of time to be occupied will probably extend to five years. Professor John R. Commons will be associated with Professor Ely, together with a corps of assistants.

THE national budget of France for the year 1904 carries an expenditure of $45,914,700 for public instruction and the fine arts, compared with $38,600,000 in 1894, or an increase of 19 per cent. in ten years.

JOHN FRANKLIN CROWELL,
Secretary, Section I, A. A. A. S.
WASHINGTON, D. C.

OPPORTUNITIES IN ANTHROPOLOGY AT THE WORLD'S FAIR.

Now that the Department of Anthropology and cognate branches of the Exposition are well under way, it has become clear that the Louisiana Purchase Exposition affords unequalled opportunities for ethnologic study. The original plans for the department are so far fulfilled (largely by the great Philippine Exhibit, the Department of Physical Culture, etc.) as to bring to the exposition the largest assemblage of the world's peoples in the world's history. Some of the alien groups have been selected especially to represent distinct ethnic types; and nearly all the groups have been selected with special reference to culture-grade, so that every known stage of industrial and social development is typified among the peoples on the exposition grounds. Accordingly, students and teachers of anthropology in all its branches may have in St. Louis during the present summer opportunities for original and instructional work such as could not be enjoyed otherwise except at the cost in time and money of extensive journeys with attendant hardships. The exposition authorities appreciate the opportunity and undertake to afford students and teachers every facility consistent with the primary purposes of the exposition.

The department comprises sections of ethnology, illustrated chiefly by living groups, partly by collections of artifacts; Indian school work, illustrated by a model school in actual operation; archeology, illustrated by typical collections and series of aboriginal artifacts; history, illustrated especially by relics and records of the transition of the territory from the aboriginal condition to that of advanced enlightenment; anthropometry, which is devoted to apparatus and laboratory work in which the assembled physical types are measured and recorded; and psychometry, likewise devoted to apparatus and laboratory tests of sense reactions and other psychic characters of the types of mankind. The four sections last named are accommodated in the Anthropology Building in the western portion of the grounds; the Indian school is housed in a special building near by; and the alien groups of the department occupy native habitations about this building and intermediate between the extensive Philippine exhibits on the south and the Physical Culture Department on the

northwest. Thus the sections of special interest to students and teachers of anthropology are fairly segregated though within easy reach of the impressive display of the achievements of modern man in the large exhibit palaces.

Among the special lines of opportunity for original and instructional work the following may be noted:

1. Somatology; the comparative study of physical types representing many distinct peoples.

2. Psychology; the study of psychic characteristics, both experimentally and through habitual conduct and expression.

3. Arts and industries; the comparative study and record of manual operations and their products among typical peoples.

4. Languages; the record and comparison of scores of distinct tongues, covering the entire range from the most primitive known to the most highly advanced.

5. Law and socialry; the comparative study of all known culture-grades as defined in terms of social organization.

6. Faiths and philosophies; the study and comparison of many widely different systems of thought, ranging from the simplest upward.

7. General ethnology; the comparative study of over a hundred distinct tribes and peoples (those brought in by the department including the Ainu, Patagonians, Pygmies, 'Red Africans,' Cocopa Indians from Baja California, Klaokwaht Indians from Vancouver Island, and over a dozen tribes of United States Indians, and the Philippine exhibit including all the leading tribes of the Archipelago).

8. General anthropology; the comparative study of primitive and advanced peoples in an unexampled assemblage of race-types and culture-grades.

9. Record work; the making and preservation of records including lists and tables of measurements, sketches and diagrams, photographs, life casts, life models, paintings, sculptures, etc.

The attention of educational institutions is especially invited to the opportunity for establishing and maintaining field schools in connection with the exposition. Every possible facility will be afforded not only by the chief of the department but by the director of exhibits and the exposition authorities generally for the satisfactory conduct of such schools.

The attention of museum officers is especially invited to the opportunities for obtaining direct representations of ethnic and other types of mankind at but a fraction of the cost ordinarily involved.

Should university, college and museum authorities signify a desire to utilize the opportunities afforded by the department, plans will be framed with the view of coordinating the requirements of all and affording each the largest facilities consistent with the demands of others; the sole purpose of the department being to place the anthropological collections of the exposition within reach of the largest possible number of workers and teachers.

Copies of this letter have been sent direct to a number of educational institutions and museums.

W J McGee.

SCIENTIFIC NOTES AND NEWS.

William Barton Rogers, the eminent geologist, was born on December 7, 1804, and the October number of the *Review* of the Massachusetts Institute of Technology will be largely given to a life of Rogers, dealing especially with his work in planning and founding the institute.

The Franklin Institute, Philadelphia, has awarded an Elliott Cresson Medal to James M. Dodge, of Philadelphia, for his cold storage system and to Dr. Hans Goldschmidt for his inventions in aluminothermics.

Senhor Augusto Ribeiro, head of the political department, Portuguese Colonial Office, and Dr. Don Eulogio Delgado, president of the Lima Geographical Society, have been elected honorary corresponding members of the Royal Geographical Society.

Dr. Willis R. Whitney, professor of theoretical chemistry at the Massachusetts Institute of Technology, has resigned to take charge of the research laboratories of the General Electrical Company's works at Schenectady.

Durham University has conferred the degree of D.Sc. on Mr. R. A. Sampson, F.R.S.,

professor of mathematics in the Durham College of Science.

THE daily papers state that Professor Frederick Starr, professor of anthropology at the University of Chicago, will resign and will make an extended expedition to Japan and China.

THE N. Y. *Evening Post* states that Professor E. W. Woodworth, of the department of entomology at the University of California, has for some time been studying silkworm culture on the Pacific Coast. He is trying to determine whether silkworms may be raised in California on a scale that would make their propagation a commercial success.

JAMES H. MONTGOMERY, Ph.D., vice-president of Allegheny College, Meadsville, Pa., member of the American Association, died on August 11, at the age of fifty years.

DR. JOSEPH WIENER, who came from Bohemia to New York in 1849 and was at one time professor of pathology in the College of Physicians and Surgeons, died on August 11, at the age of seventy-six years.

DR. FRIEDRICH RATZEL, professor of geography at Leipzig, well-known in this country for his important work on the geography of North America, died on August 9.

THE deaths are announced of Sir William Banks, a well-known British surgeon who took a prominent part in the work of the medical school of the University of Liverpool, where he was emeritus professor of anatomy, and of Sir Frederic Bateman, a prominent physician of Norwich, the author of works on aphasia and other subjects.

THERE will be a civil service examination on September 14 and 15 to fill a vacancy in the position of anatomist (male), at $1,600 per annum, in the Army Medical Museum, office of the surgeon-general, and other similar vacancies as they may occur.

THE committee appointed by the Texas legislature to investigate methods for the extermination of the boll weevil and pay a reward of $50,000 to the discoverer of any such method has decided that no one has earned this reward.

THE American Microscopical Society will meet at Buffalo, New York, on August 23, 24 and 25, under the presidency of Professor T. J. Burrill, of the University of Illinois. The meetings will be held in the lecture room of the Buffalo Society of Natural History, Hotel Lafayette being the headquarters. The subject of the president's address, which will be given on the evening of August 24, will be 'Microorganisms of the soil and human welfare.' Attention may be called to the fact that this meeting is the consummation of 25 years of existence and is therefore of special interest. A National Microscopical Congress, held at Indianapolis, Ind., in 1878, appointed a committee on organization, and at Buffalo, N. Y., in 1879, was founded the American Society of Microscopists, which, in 1892, became the American Microscopical Society; thus the twenty-fifth year of the society's existence ends with this meeting, the twenty-seventh if we count the meeting in Indianapolis, the twenty-sixth if we begin with the Buffalo meeting.

THE St. Marylebone Natural Science Society, London, which has been in existence for the past six years, has celebrated the opening of a new museum and lecture hall, 444 Edgware Road. The work of the society is carried out entirely by working people and is self-supporting.

A LONG vacation course which lasted till August 16, was arranged by the Oxford School of Geography, and was opened with an introductory address by Mr. H. J. Mackinder, student of Christ Church and reader in geography. According to a report in the London *Times* he said they were met together as a body of secondary and university teachers for the purpose of what he might describe as mental refreshment. It was their intention to spend the greater part of the next three weeks in the study of geography. Summer schools, of course, had their limitations, but none were more defensible than those intended for teachers. If secondary teaching was to retain its vitality, it was essential that, in the narrower subjects at any rate, there should be periodical contact between those whose daily duty it was to teach in school and those who were fortu-

nate enough to be mainly occupied in the advancement of their subject. No reading, however assiduous, could possibly replace the influence of personal intercourse. As regarded geography and education, he was delighted to tell them that real progress was being made. The lead originally given by the University of Oxford, acting in conjunction with the Royal Geographical Society, was being followed in other universities. The University of Cambridge was at this moment taking very active steps, which he trusted would meet with great success. The Universities of Liverpool and Manchester were placing economic geography under specialist teachers, in a favored position in the *curricula* of their new commercial degrees, and the University of Birmingham was following the lead of the University of London and of the London School of Economics. One thing, however, he regretted, that in the *curriculum* recently adopted by the British universities for the preparation of army candidates military topography, in the narrower sense, but not geography in the larger, had found a place. In this respect they were behind continental education. Surely, after the lessons in the Boer war, it was obvious that officers should above all things learn to think in terms of space, and in his experience this power came by the light of nature only to a very small percentage even of educated men. The whole basis of geography—and it was a thing which at this moment required saying in the light of certain tendencies in their universities—the whole basis of geography was physical. Historical and economic geography were merely empirical and unworthy of university study unless they regarded them as applications of physical geography. In fact, he claimed it as perhaps the happiest function of the subject that it should act as a link between the faculties of arts and natural science, which, owing to vested interests, were too much separated. A hybrid degree in arts and science mixed would in this twentieth century be one of the finest preparations for practical life in the world. It was grotesque that men should be regarded as educated who did not know even the modes of scientific thought. It was equally absurd that scientific students should be regarded as educated if they had not availed themselves of the teaching of the humanities, which was a legacy of the past.

UNIVERSITY AND EDUCATIONAL NEWS.

Soon after the opening of the fall term the corner stone of the new library at Stanford University will be laid. It will cost $750,000, and have a capacity of 1,000,000 books.

It is reported that Mr. Henry Phipps has given $20,000 to the Johns Hopkins University for the study of tuberculosis.

The Drapers Company of London will give £30,000 toward paying the debt on the land and buildings of University College, London, to enable the College to be incorporated in the University of London.

The St. Andrews diploma of L.L.A.—which means 'lady literate in arts'!—has been given this year on examination to 101 candidates. It appears that 1,400 papers were written and passes were obtained in 766 instances. The distribution of subjects is rather curious. Nine passed in Latin, two in Greek, two in zoology, two in natural philosophy, seventy in geography, twenty-eight in botany, seventy in physiology, etc.

Dr. W. H. Newbold, professor of philosophy in the University of Pennsylvania, has resigned the deanship of the graduate school.

Dr. Frank Allen, senior instructor in physics in Cornell University, has been appointed to a lately established professorship in physics in the University of Manitoba, Winnipeg, Canada.

In the University of London, Dr. Edward Westermarck, formerly lecturer on sociology in the University of Finland, has been appointed lecturer in sociology (in connection with the Martin White benefaction); Mr. W. Legge Symes, M.R.C.S., university demonstrator in physiology; and Miss Beatrice Edgell, M.A., Ph.D., demonstrator in experimental psychology.

SCIENCE

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*REFLECTIONS SUGGESTED BY THE NEW THEORY OF MATTER.**

THE meetings of this great society have for the most part been held in crowded centers of population, where our surroundings never permit us to forget, were such forgetfulness in any case possible, how close is the tie that binds modern science to modern industry, the abstract researches of the student to the labors of the inventor and the mechanic. This, no doubt, is as it should be. The interdependence of theory and practice can not be ignored without inflicting injury on both; and he is but a poor friend to either who undervalues their mutual cooperation.

Yet, after all, since the British Association exists for the advancement of science, it is well that now and again we should choose our place of gathering in some spot where science rather than its applications, knowledge, not utility, are the ends to which research is primarily directed.

If this be so, surely no happier selection could have been made than the quiet courts of this ancient university. For here, if anywhere, we tread the classic ground of physical discovery. Here, if anywhere, those who hold that physics is the true *Scientia Scientiarum,* the root of all the sciences which deal with inanimate nature, should feel themselves at home. For, unless I am led astray by too partial an affection for my own university, there is nowhere to be found, in any corner of the

* Address of the President of the British Association for the Advancement of Science, Cambridge, 1904.

world, a spot with which have been connected, either by their training in youth, or by the labors of their maturer years, so many men eminent as the originators of new and fruitful physical conceptions. I say nothing of Bacon, the eloquent prophet of a new era; nor of Darwin, the Copernicus of biology; for my subject to-day is not the contributions of Cambridge to the general growth of scientific knowledge. I am concerned rather with the illustrious line of physicists who have learned or taught within a few hundred yards of this building—a line stretching from Newton in the seventeenth century, through Cavendish in the eighteenth, through Young, Stokes, Maxwell, in the nineteenth, through Kelvin, who embodies an epoch in himself, down to Rayleigh, Larmor, J. J. Thomson, and the scientific school centered in the Cavendish laboratory, whose physical speculations bid fair to render the closing years of the old century and the opening years of the new as notable as the greatest which have preceded them.

Now what is the task which these men, and their illustrious fellow-laborers out of all lands, have set themselves to accomplish? To what end led these 'new and fruitful physical conceptions' to which I have just referred? It is often described as the discovery of the 'laws connecting phenomena.' But this is certainly a misleading, and, in my opinion, a very inadequate, account of the subject. To begin with, it is not only inconvenient, but confusing, to describe as 'phenomena' things which do not appear, which never have appeared, and which never can appear, to beings so poorly provided as ourselves with the apparatus of sense perception. But apart from this, which is a linguistic error too deeply rooted to be easily exterminated, is it not most inaccurate in substance to say that a knowledge of nature's laws is all we seek when investigating nature? The physicist looks for something more than what, by any stretch of language, can be described as 'co-existences' and 'sequences' between so-called 'phenomena.' He seeks for something deeper than the laws connecting possible objects of experience. His object is physical reality: a reality which may or may not be capable of direct perception; a reality which is in any case independent of it; a reality which constitutes the permanent mechanism of that physical universe with which our immediate empirical connection is so slight and so deceptive. That such a reality exists, though philosophers have doubted, is the unalterable faith of science; and were that faith *per impossible* to perish under the assaults of critical speculation, science, as men of science usually conceive it, would perish likewise.

If this be so, if one of the tasks of science, and more particularly of physics, is to frame a conception of the physical universe in its inner reality, then any attempt to compare the different modes in which, at different epochs of scientific development, this intellectual picture has been drawn, can not fail to suggest questions of the deepest interest. True, I am precluded from dealing with such of these questions as are purely philosophical by the character of this occasion; and with such of them as are purely scientific by my own incompetence. But some there may be sufficiently near the dividing line to induce the specialists who rule by right on either side of it to view with forgiving eyes any trespasses into their legitimate domain which I may be tempted, during the next few minutes, to commit.

Let me, then, endeavor to compare the outlines of two such pictures, of which the first may be taken to represent the views prevalent towards the end of the eighteenth century; a little more than a hundred years from the publication of Newton's 'Prin-

cipia,' and, roughly speaking, about midway between that epoch-making date and the present moment. I suppose that if at that period the average man of science had been asked to sketch his general conception of the physical universe, he would probably have said that it essentially consisted of various sorts of ponderable matter, scattered in different combinations through space, exhibiting most varied aspects under the influence of chemical affinity and temperature, but through every metamorphosis obedient to the laws of motion, always retaining its mass unchanged, and exercising at all distances a force of attraction on other material masses, according to a simple law. To this ponderable matter he would (in spite of Rumford) have probably added the so-called 'imponderable' heat, then often ranked among the elements; together with the two 'electrical fluids,' and the corpuscular emanations supposed to constitute light.

In the universe as thus conceived, the most important forms of action between its constituents was action at a distance; the principle of the conservation of energy was, in any general form, undreamed of; electricity and magnetism, though already the subjects of important investigation, played no great part in the whole of things; nor was a diffused ether required to complete the machinery of the universe.

Within a few months, however, of the date assigned for these deliverances of our hypothetical physicist, came an addition to this general conception of the world, destined profoundly to modify it. About a hundred years ago Young opened, or reopened, the great controversy which finally established the undulatory theory of light, and with it a belief in an interstellar medium by which undulations could be conveyed. But this discovery involved much more than the substitution of a theory of light which was consistent with the facts for one which was not; since here was the first authentic introduction* into the scientific world-picture of a new and prodigious constituent—a constituent which has altered, and is still altering, the whole balance (so to speak) of the composition. Unending space, thinly strewn with suns and satellites, made or in the making, supplied sufficient material for the mechanism of the heavens as conceived by Laplace. Unending space filled with a continuous medium was a very different affair, and gave promise of strange developments. It could not be supposed that the ether, if its reality were once admitted, existed only to convey through interstellar regions the vibrations which happen to stimulate the optic nerve of man. Invented originally to fulfil this function, to this it could never be confined. And accordingly, as every one now knows, things which, from the point of view of sense perception, are as distinct as light and radiant heat, and things to which sense perception makes no response, like the electric waves of wireless telegraphy,† intrinsically differ, not in kind, but in magnitude alone.

This, however, is not all, nor nearly all. If we jump over the century which separates 1804 from 1904, and attempt to give in outline the world-picture as it now presents itself to some leaders of contemporary speculation, we shall find that in the interval it has been modified, not merely by such far-reaching discoveries as the atomic and molecular composition of ordinary matter, the kinetic theory of gases, and the laws of the conservation and dissipation of energy, but by the more and more important part which electricity and the ether

* The hypothesis of an ether was, of course, not new. But before Young and Fresnel it can not be said to have been established.

† First known through the theoretical work of Maxwell and the experiments of Herz.

occupy in any representation of ultimate physical reality.

Electricity was no more to the natural philosophers in the year 1700 than the hidden cause of an insignificant phenomenon.* It was known, and had long been known, that such things as amber and glass could be made to attract light objects brought into their neighborhood; yet it was about fifty years before the effects of electricity were perceived in the thunderstorm. It was about 100 years before it was detected in the form of a current. It was about 120 years before it was connected with magnetism; about 170 years before it was connected with light and ethereal radiation.

But to-day there are those who regard gross matter, the matter of everyday experience, as the mere appearance of which electricity is the physical basis; who think that the elementary atom of the chemist, itself far beyond the limits of direct perception, is but a connected system of monads or sub-atoms which are not electrified matter, but are electricity itself; that these systems differ in the number of monads which they contain, in their arrangement, and in their motion relative to each other and to the ether; that on these differences, and on these differences alone, depend the various qualities of what have hitherto been regarded as indivisible and elementary atoms; and that while in most cases these atomic systems may maintain their equilibrium for periods which, compared with such astronomical processes as the cooling of a sun, may seem almost eternal, they are not less obedient to the law of change than the everlasting heavens themselves.

But if gross matter be a grouping of atoms, and if atoms be systems of electrical monads, what are these electrical monads? It may be that, as Professor Larmor has suggested, they are but a modification of the universal ether, a modification roughly comparable to a knot in a medium which is inextensible, incomprehensible and continuous. But whether this final unification be accepted or not, it is certain that these monads can not be considered apart from the ether. It is not on their interaction with the ether that their qualities depend; and without the ether an electric theory of matter is impossible.

Surely we have here a very extraordinary revolution. Two centuries ago electricity seemed but a scientific toy. It is now thought by many to constitute the reality of which matter is but the sensible expression. It is but a century ago that the title of an ether to a place among the constituents of the universe was authentically established. It seems possible now that it may be the stuff out of which that universe is wholly built. Nor are the collateral inferences associated with this view of the physical world less surprising. It used, for example, to be thought that mass was an original property of matter, neither capable of explanation nor requiring it; in its nature essentially unchangeable, suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to, or identified with, each material fragment, howsoever much that fragment might vary in its appearance, its bulk, its chemical or its physical condition.

But if the new theories be accepted these views must be revised. Mass is not only explicable, it is actually explained. So far from being an attribute of matter considered in itself, it is due, as I have said, to the relation between the electrical monads of which matter is composed and the ether in which they are bathed. So far from being unchangeable, it changes, when mov-

* The modern history of electricity begins with Gilbert but I have throughout confined my observations to the post-Newtonian period.

ing at very high speeds, with every change in its velocity.

Perhaps, however, the most impressive alteration in our picture of the universe required by these new theories is to be sought in a different direction. We have all, I suppose, been interested in the generally accepted views as to the origin and development of suns with their dependent planetary systems; and the gradual dissipation of the energy which during this process of concentration has largely taken the form of light and radiant heat. Follow out the theory to its obvious conclusions, and it becomes plain that the stars now visibly incandescent are those in mid-journey between the nebulæ from which they sprang and the frozen darkness to which they are predestined. What, then, are we to think of the invisible multitude of the heavenly bodies in which this process has been already completed? According to the ordinary view, we should suppose them to be in a state where all possibilities of internal movement were exhausted. At the temperature of interstellar space their constituent elements would be solid and inert; chemical action and molecular movement would be alike impossible, and their exhausted energy could obtain no replenishment unless they were suddenly rejuvenated by some celestial collision, or traveled into other regions warmed by newer suns.

This view must, however, be profoundly modified if we accept the electric theory of matter. We can then no longer hold that if the internal energy of a sun were as far as possible converted into heat either by its contraction under the stress of gravitation or by chemical reactions between its elements, or by any other inter-atomic force; and that, were the heat so generated to be dissipated, as in time it must be, through infinite space, its whole energy would be exhausted. On the contrary, the amount thus lost would be absolutely insignificant compared with what remained stored up within the separate atoms. The system in its corporate capacity would become bankrupt—the wealth of its individual constituents would be scarcely diminished. They would lie side by side, without movement, without chemical affinity; yet each one, howsoever inert in its external relations, the theater of violent motions, and of powerful internal forces.

Or, put the same thought in another form. When the sudden appearance of some new star in the telescopic field gives notice to the astronomer that he, and perhaps, in the whole universe, he alone, is witnessing the conflagration of a world, the tremendous forces by which this far-off tragedy is being accomplished must surely move his awe. Yet not only would the members of each separate atomic system pursue their relative course unchanged, while the atoms themselves were thus riven violently apart in flaming vapor, but the forces by which such a world is shattered are really *négligeable* compared with those by which each atom of it is held together.

In common, therefore, with all other living things, we seem to be practically concerned chiefly with the feebler forces of nature, and with energy in its least powerful manifestations. Chemical affinity and cohesion are on this theory no more than the slight residual effects of the internal electrical forces which keep the atom in being. Gravitation, though it be the shaping force which concentrates nebulæ into organized systems of suns and satellites, is trifling compared with the attractions and repulsions with which we are familiar between electrically charged bodies; while these again sink into insignificance beside the attractions and repulsions between the electric monads themselves. The irregular molecular movements which constitute heat, on which the very possibility of organic life seems absolutely to hang, and in whose

transformations applied science is at present so largely concerned, can not rival the kinetic energy stored within the molecules themselves. This prodigious mechanism seems outside the range of our immediate interests. We live, so to speak, merely on its fringe. It has for us no promise of utilitarian value. It will not drive our mills; we can not harness it to our trains. Yet not less on that account does it stir the intellectual imagination. The starry heavens have from time immemorial moved the worship or the wonder of mankind. But if the dust beneath our feet be indeed compounded of innumerable systems, whose elements are ever in the most rapid motion, yet retain through uncounted ages their equilibrium unshaken, we can hardly deny that the marvels we directly see are not more worthy of admiration than those which recent discoveries have enabled us dimly to surmise.

Now, whether the main outlines of the world-picture which I have just imperfectly presented to you be destined to survive, or whether in their turn they are to be obliterated by some new drawing on the scientific palimpsest, all will, I think, admit that so bold an attempt to unify physical nature excites feelings of the most acute intellectual gratification. The satisfaction it gives is almost esthetic in its intensity and quality. We feel the same sort of pleasurable shock as when from the crest of some melancholy pass we first see far below us the sudden glories of plain, river and mountain. Whether this vehement sentiment in favor of a simple universe has any theoretical justification I will not venture to pronounce. There is no *a priori* reason that I know of for expecting that the material world should be a modification of a single medium, rather than a composite structure built out of sixty or seventy elementary substances, eternal and eternally different. Why, then, should we feel content with the first hypothesis and not with the second? Yet so it is. Men of science have always been restive under the multiplication of entities. They have eagerly noted any sign that the chemical atom was composite, and that the different chemical elements had a common origin. Nor, for my part, do I think such instincts should be ignored. John Mill, if I rightly remember, was contemptuous of those who saw any difficulty in accepting the doctrine of 'action at a distance.' So far as observation and experiment can tell us, bodies *do* actually influence each other at a distance. And why should they not? Why seek to go behind experience in obedience to some *a priori* sentiment for which no argument can be adduced? So reasoned Mill, and to his reasoning I have no reply. Nevertheless, we can not forget that it was to Faraday's obstinate disbelief in 'action at a distance' that we owe some of the crucial discoveries on which both our electric industries and the electric theory of matter are ultimately founded; while at this very moment physicists, however baffled in the quest for an explanation of gravity, refuse altogether to content themselves with the belief, so satisfying to Mill, that it is a simple and inexplicable property of masses acting on each other across space.

These obscure intimations about the nature of reality deserve, I think, more attention than has yet been given to them. That they exist is certain; that they modify the indifferent impartialitiy of pure empiricism can hardly be denied. The common notion that he who would search out the secrets of nature must humbly wait on experience, obedient to its slightest hint, is but partly true. This may be his ordinary attitude; but now and again it happens that observation and experiment are not treated as guides to be meekly followed, but as witnesses to be broken down in cross-examina-

tion. Their plain message is disbelieved, and the investigating judge does not pause until a confession in harmony with his preconceived ideas has, if possible, been wrung from their reluctant evidence.

This proceeding needs neither explanation nor defence in those cases where there is an apparent contradiction between the utterances of experience in different connections. Such contradictions must of course be reconciled, and science can not rest until the reconciliation is effected. The difficulty really arises when experience apparently says one thing and scientific instinct persists in saying another. Two such cases I have already mentioned; others will easily be found by those who care to seek. What is the origin of this instinct, and what its value; whether it be a mere prejudice to be brushed aside, or a clue which no wise man would disdain to follow, I can not now discuss. For other questions there are, not new, yet raised in an acute form by these most modern views of matter, on which I would ask your indulgent attention for yet a few moments.

That these new views diverge violently from those suggested by ordinary observation is plain enough. No scientific education is likely to make us, in our unreflective moments, regard the solid earth on which we stand, or the organized bodies with which our terrestrial fate is so intimately bound up, as consisting wholly of electric monads very sparsely scattered through the spaces which these fragments of matter are, by a violent metaphor, described as 'occupying.' Not less plain is it that an almost equal divergence is to be found between these new theories and that modification of the common-sense view of matter with which science has in the main been content to work.

What was this modification of common sense? It is roughly indicated by an old philosophic distinction drawn between what were called the 'primary' and the 'secondary' qualities of matter. The primary qualities, such as shape and mass, were supposed to possess an existence quite independent of the observer; and so far the theory agreed with common sense. The secondary qualities, on the other hand, such as warmth and color, were thought to have no such independent existence, being, indeed, no more than the resultants due to the action of the primary qualities on our organs of sense-perception; and here, no doubt, common sense and theory parted company.

You need not fear that I am going to drag you into the controversies with which this theory is historically connected. They have left abiding traces on more than one system of philosophy. They are not yet solved. In the course of them the very possibility of an independent physical universe has seemed to melt away under the solvent powers of critical analysis. But with all this I am not now concerned. I do not propose to ask what proof we have that an external world exists, or how, if it does exist, we are able to obtain cognisance of it. These may be questions very proper to be asked by philosophy; but they are not proper questions to be asked by science. For, logically, they are antecedent to science, and we must reject the sceptical answers to both of them before physical science becomes possible at all. My present purpose requires me to do no more than observe that, be this theory of the primary and secondary qualities of matter good or bad, it is the one on which science has in the main proceeded. It was with matter thus conceived that Newton experimented. To it he applied his laws of motion; of it he predicated universal gravitation. Nor was the case greatly altered when science became as much preoccupied with the movements of molecules as it was with those of planets. For molecules and atoms, what-

ever else might be said of them, were at least pieces of matter, and, like other pieces of matter, possessed those 'primary' qualities supposed to be characteristic of all matter, whether found in large masses or in small.

But the electric theory which we have been considering carries us into a new region altogether. It does not confine itself to accounting for the secondary qualities by the primary, or the behavior of matter in bulk by the behavior of matter in atoms; it analyses matter, whether molar or molecular, into something which is not matter at all. The atom is now no more than the relatively vast theater of operations in which minute monads perform their orderly evolutions; while the monads themselves are not regarded as units of matter, but as units of electricity; so that matter is not merely explained, but is explained away.

Now the point to which I desire to call attention is not to be sought in the great divergence between matter as thus conceived by the physicist and matter as the ordinary man supposes himself to know it, between matter as it is perceived and matter as it really is, but to the fact that the first of these two quite inconsistent views is wholly based on the second.

This is surely something of a paradox. We claim to found all our scientific opinions on experience; and the experience on which we found our theories of the physical universe is our *sense-perception* of that universe. That *is* experience; and in this region of belief there is no other. Yet the conclusions which thus profess to be entirely founded upon experience are to all appearance fundamentally opposed to it; our knowledge of reality is based upon illusion, and the very conceptions we use in describing it to others, or in thinking of it ourselves, are abstracted from anthropomorphic fancies, which science forbids us to believe and nature compels us to employ.

We here touch the fringe of a series of problems with which inductive logic ought to deal, but which that most unsatisfactory branch of philosophy has systematically ignored. This is no fault of men of science. They are occupied in the task of making discoveries, not in that of analyzing the fundamental presuppositions which the very possibility of making discoveries implies. Neither is it the fault of transcendental metaphysicians. Their speculations flourish on a different level of thought; their interest in a philosophy of nature is lukewarm; and howsoever the questions in which they are chiefly concerned be answered, it is by no means certain that the answers will leave the humbler difficulties at which I have hinted either nearer to or further from a solution. But though men of science and idealists stand acquitted, the same can hardly be said of empirical philosophers. So far from solving the problem, they seem scarcely to have understood that there was a problem to be solved. Led astray by a misconception to which I have already referred; believing that science was concerned only with (so-called) 'phenomena,' that it had done all that it could be asked to do if it accounted for the sequence of our individual sensations, that it was concerned only with the 'laws of nature,' and not with the inner character of physical reality; disbelieving, indeed, that any such physical reality does in truth exist;—it has never felt called upon seriously to consider what are the actual methods by which science attains its results, and how those methods are to be justified. If anyone, for example, will take up Mill's logic, with its 'sequences and co-existences between phenomena,' its 'method of difference,' its 'method of agreement,' and the rest; if he will then compare the actual doctrines of science with this version of the mode in which those doc-

trines have been arrived at,—he will soon be convinced of the exceedingly thin intellectual fare which has been hitherto served out to us under the imposing title of Inductive Theory.

There is an added emphasis given to these reflections by a train of thought which has long interested me, though I acknowledge that it never seems to have interested anyone else. Observe, then, that in order of logic sense-perceptions supply the premises from which we draw all our knowledge of the physical world. It is they which tell us there *is* a physical world; it is on their authority that we learn its character. But in order of causation they are effects due (in part) to the constitution of our organs of sense. What we see depends not merely on what there is to be seen, but on our eyes. What we hear depends not merely on what there is to hear, but on our ears. Now, eyes and ears, and all the mechanism of perception, have, as we know, been evolved in us and our brute progenitors by the slow operation of natural selection. And what is true of sense-perception is of course also true of the intellectual powers which enable us to erect upon the frail and narrow platform which sense-perception provides, the proud fabric of the sciences.

Now natural selection only works through utility. It encourages aptitudes useful to their possessor or his species in the struggle for existence, and, for a similar reason, it is apt to discourage useless aptitudes, however interesting they may be from other points of view, because, being useless, they are probably burdensome.

But it is certain that our powers of sense-perception and of calculation were fully developed ages before they were effectively employed in searching out the secrets of physical reality—for our discoveries in this field are the triumphs but of yesterday. The blind forces of natural selection, which so admirably simulate design when they are providing for a present need, possess no power of prevision, and could never, except by accident, have endowed mankind, while in the making, with a physiological or mental outfit adapted to the higher physical investigations. So far as natural science can tell us, every quality of sense or intellect which does not help us to fight, to eat, and to bring up children, is but a by-product of the qualities which do. Our organs of sense-perception were not given us for purposes of research; nor was it to aid us in meting out the heavens or dividing the atom that our powers of calculation and analysis were evolved from the rudimentary instincts of the animal.

It is presumably due to these circumstances that the beliefs of all mankind about the material surroundings in which it dwells are not only imperfect but fundamentally wrong. It may seem singular that down to, say, five years ago, our race has, without exception, lived and died in a world of illusions; and that its illusions, or those with which we are here alone concerned, have not been about things remote or abstract, things transcendental or divine, but about what men see and handle, about those 'plain matters of fact' among which common sense daily moves with its most confident step and most self-satisfied smile. Presumably, however, this is either because too direct a vision of physical reality was a hindrance, not a help, in the struggle for existence; because falsehood was more useful than truth; or else because with so imperfect a material as living tissue no better results could be attained. But, if this conclusion be accepted, its consequences extend to other organs of knowledge besides those of perception. Not merely the senses, but the intellect, must be judged by it: and it is hard to see why evolution, which has so lamentably failed to produce trustworthy instruments for obtaining the

raw material of experience, should be credited with a larger measure of success in its provision of the physiological arrangements which condition reason in its endeavors to turn experience to account.

Considerations like these, unless I have compressed them beyond the limits of intelligibility, do undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which is built out of materials provided by natural science alone. Extend the boundaries of knowledge as you may; draw how you will the picture of the universe; reduce its infinite variety to the modes of a single space-filling ether; retrace its history to the birth of existing atoms; show how under the pressure of gravitation they became concentrated into nebulæ, into suns, and all the host of heaven; how, at least in one small planet, they combined to form organic compounds; how organic compounds became living things; how living things, developing along many different lines, gave birth at last to one superior race; how from this race arose, after many ages, a learned handful, who looked round on the world which thus blindly brought them into being, and judged it, and knew it for what it was—perform, I say, all this, and, though you may indeed have attained to science, in nowise will you have attained to a self-sufficing system of beliefs. One thing at least will remain, of which this long-drawn sequence of causes and effects gives no satisfying explanation; and that is knowledge itself. Natural science must ever regard knowledge as the product of irrational conditions, for in the last resort it knows no others. It must always regard knowledge as rational, or else science itself disappears. In addition, therefore, to the difficulty of extracting from experience beliefs which experience contradicts, we are confronted with the difficulty of harmonizing the pedigree of our beliefs with their title to authority. The more successful we are in explaining their origin, the more doubt we cast on their validity. The more imposing seems the scheme of what we know, the more difficult it is to discover by what ultimate criteria we claim to know it.

Here, however, we touch the frontier beyond which physical science possesses no jurisdiction. If the obscure and difficult region which lies beyond is to be surveyed and made accessible, philosophy, not science, must undertake the task. It is no business of this society. We meet here to promote the cause of knowledge in one of its great divisions; we shall not help it by confusing the limits which usefully separate one division from another. It may perhaps be thought that I have disregarded my own precept—that I have wilfully overstepped the ample bounds within which the searchers into nature carry on their labors. If it be so, I can only beg your forgiveness. My first desire has been to rouse in those who, like myself, are no specialists in physics, the same absorbing interest which I feel in what is surely the most far-reaching speculation about the physical universe which has ever claimed experimental support; and if in so doing I have been tempted to hint my own personal opinion that as natural science grows it leans more, not less, upon an idealistic interpretation of the universe, even those who least agree may perhaps be prepared to pardon.

A. J. Balfour.

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*Science and the People.**

Opportunities beget responsibilities. On such an occasion as this, he who has been honored with the opportunity is tempted to address you upon a specialized subject to which he has given years of thought and

* Retiring address of the president of the North Carolina Academy of Science, Wake Forest College, May 13, 1904.

interest, but the opportunity carries with it corresponding responsibilities beyond the narrow bounds of one's limited investigations. The audience is composed in part of the general public, which is more or less informed, or misinformed through no self-fault, as to the general trend of scientific thought and movement; in part of students, some enwrapt with the beauty and majesty of ancient art and philosophy, others versed in the history of science and conversant with its latest conceptions; in part, my hearers are specialists in the varied branches of science, so I feel much like Moleschott in his address at the reopening of the University of Rome, when he found himself 'in the face of an audience whom he had nothing to teach, but from whom he had much to learn.'

The groundwork of science may be thrown into three divisions: (1) laborers who work; (2) tools they must employ; and (3) that which constitutes the fields of their labors.

In the world we know there is such a thing as progress; that civilization is dependent upon something capable of increase, evidently knowledge. Although, as Schiller has said, 'Knowledge is to one a goddess, to another an excellent cow,' yet the momentum of progress is largely, if not altogether, given by science.

Variations in social conditions have caused variations in human standards of morality, but through all the ages morality has actually been a stationary thing. Different ages have known mighty things in literature and art, but each was the individual outcome of the pen or brush of the genius, who bequeathed a heritage of his own labors as a stimulus to others; but the mastership passed with him. Not so with science; for, as Whewell has said, 'It is not a collection of miscellaneous, uncorrected, unarranged knowledge that can be considered as constituting science.'

Different ages have known mighty things in science, sometimes as the outcome of a genius, but equally as often the consequence of talent building upon that which was learned before. So, never was one more mistaken than President Woodrow Wilson when he stated that science breaks with the past.

In order to appreciate the spirit of modern science, we must take a hurried glance at the motives prompting the older workers and consider their environment. We are aware, in the historical development of things, that all present knowledge arose from a chaotic state enveloping itself in mystery. This was due to the empirical means of observation, superstition attending any inquiry into the why of things, hampering circumscriptions of religions, primitive and more recent, and lack of means of communication. The wise man, exercising a little common sense, wrought cures wonderful in those dark times, many simple for the youngest practitioner of to-day. While, doubtless, some were prompted by an earnest desire to do good, many were actuated by greed of power and gain, even as to-day. Fearful of their loss once secured, they often sought to hide their own shortcomings and take advantage of the universal ignorance by their mysticism. These were not the sole motives of all workers, however. The spirit of inquiry has ever been present with mankind. For

> Ignorance is the curse of God,
> Knowledge the wings wherewith we fly to heaven.

Although, three hundred years before Christ, the living and dead were dissected at the Alexandrian School, it was not until the fifteenth century that the popes overcame popular prejudice about the sanctity of the dead body and issued edicts permitting dissection. The following century, Vesalius arose, and then Harvey discovered the circulation of the blood. Greek philos-

ophers first endeavored to place science upon a purely rational basis and they were accused of impiety. To be sure, it may be said that such impeachments have not ceased to sound for over two thousand years and cost the lives of many good and noble men. The church considered Galileo and similar workers as rank heretics. Certain scientific endeavors were tolerated, and the knowledge gained confined within monastic walls. In the hearts of some was that yearning to make known the truths they had dreamed; and monks like Roger Bacon, Basil Valentine and Berthold Schwartz put forth writings so mysterious as to be incomprehensible to many, but having hidden realities not previously made known.

Science was centuries acquiring its natural voice. In the dark ages only a small band of learned folk made itself known, yet the voice of Kepler, saying 'The scientist's highest privilege is to know the mind and to think the thoughts of God,' sounded three centuries ago, has echoed with increasing reverberations to our own time. Science, harassed by ding-dong, useless and unnecessary authority, was driven into rigid pious paths. As the very spirit of science is inquiry, it lives upon liberty and would not be bound by authoritative misconceptions. It is not strange, then, that in a democracy of thought permitting the widest range of opinions men should have been borne away to the other extreme, and such catching expressions as 'every one for himself and no god for any one' became prevalent. 'Scientific arrogance' was a pet expression of theologians who trespassed none the less than had the scientists. 'The abuse heaped upon Newton for substituting blind gravitation for an intelligible Deity' that John Fiske tells about, was nothing in comparison with the subsequent treatment of geologists by theologians for disturbing the Biblical chronology. The highest teaching of scientific verities is the absolute necessity for the existence of God. In fact, one need not go far for a chemical confirmation of the resurrection, as death is but a phase of our continual internal change; 'so when this corruptible shall have put on incorruption and this mortal shall have put on immortality,' our natural body sown in dishonor and weakness, shall be raised a spiritual body, clothed in glory and power; 'and as we have borne the image of the earthly, we shall also bear the image of the heavenly.' It is only in the most modern times that the scientific spirit, which looks to the relative and temporarily excludes the absolute, has begun to be fully applied and extended to ideas of every order.

I am by no means unmindful of the dogmatism of science at times, for it may be recalled that Daguerre was actually temporarily incarcerated in an asylum because he maintained he could transfer his likeness to a tin plate; Franklin's paper on lightning conductors was laughed at and not published by the Royal Society; and Galvani was attacked by his colleagues, designated a know-nothing, and called 'the frog's dancing master.' The Count de Gasparin even wrote in the *Journal des Débats*, 'Take care; the representations of the exact sciences are on their way to become the inquisitors of our days.'

Science does not pretend to say the last word in regard to the universe, but it builds hypotheses upon observed and unobserved facts which are altered or cast aside in the light of all new correctly obtained facts. It is ever ready to declare the increasing uncertainty of many delightful and ideal conceits, which is not to be taken as vacillation, but as evolution, growth. The late distinguished Lord Playfair at the Aberdeen meeting of the British Association said: "The changing theories which the world despises are the leaves of the tree of science drawing nutriment to the parent

stems, and enabling it to put forth new branches and to produce fruit; and, though the leaves fall and decay, the very products of decay nourish the roots of the tree and reappear in the new leaves or theories which succeed.'' With this spirit, it will not hesitate to attack any of our pet scientific, sociological or theological dogmas, which are frail as all human systems must be. These attacks are without venom, however, for ''Science * * * requires for its satisfactory prosecution the employment of our very noblest powers, and it is by them alone that we can hope to attain a knowledge of the most supreme and ultimate truths which our intellectual faculties have the power to apprehend.''—(Mivart.)

Although Gough remarked to Dalton, 'The human mind is naturally partial to its own conceptions and frequently condescends to practise a little self-delusion when obliged by the force of facts and arguments to abandon a favorite notion,' the supreme lesson in the history of science, most marked in our own time, is the pursuit of truth. Much time has been spent in defining *art* and casting that which did not fit a pet definition into a rubbish box called *science,* or 'natural knowledge' as a member of the Royal Society was pleased to term it. Many of those insisting upon such a classification are not without reason, for have not certain phylogenetics promulgated on the flimsiest excuse some *pan mixia,* as Weismann's germ-plasm theory and then easily remembering the conclusions, but forgetful of the evidence, maintained that it was a law? Or has not a Tesla over magnanimously taken the public into his confidential conversations with the inhabitants of Mars?

It has been fashionable in years gone by to say that poetry and truth were antagonistic. Coleridge and Poe, I think, insisted that science and poetry were irreconcilable. Incongruous statements, as when Shakespeare speaks of a toothache 'as humor or a worm,' doubtless gave rise to such thoughts. The Avon poet put it according to the scientific teachings of his time. Civilization and methods of interpreting the truth change and progress, but truth itself is eternal. Science will no more replace literature than can a geometric diagram be substituted for a landscape painting.

Science, to be sure, is destructive of conventions. Freedom is the breath of science, and the unshackled movement of boundless human curiosity must affect literature. Men of science look not pleasantly upon their scavenging camp followers, who, riotous in thought, indulge in a license of speech which provokes quite justly those who conscientiously differ from them, and unfortunately inculcates ideas in those unable to winnow the chaff from the grain.

Thus it may be seen that modern science makes for purity and genuineness. There is nothing more abhorrent to a man of science than the pretenses of a scientific mountebank. This elevation is dual in its effect, general and local. As an evidence of the former there have resulted ameliorated conditions of society by protecting food from harmful adulterations, improved sanitation, better and more reasonable treatment for diseases, general distribution of the products of wealth among all civilized peoples, and in many other ways too numerous to mention. A reader after Count Tolstoy and his 'recognition of the bankruptcy of experimental science,' can not but be impressed with his earnestness, and yet feel that he looks only very close at home when he writes: ''The men of science of our time think and speak and the crowd follows them, while at the same time there was never a period or a people among whom science in its complete significance stood on so low a level as our science to-day. One part of it, that which

should study what makes life of man good and happy, is occupied in justifying the existing evil conditions, while another part spends its time solving questions of idle curiosity." He does not apparently realize that science promotes a certain continuity of ideas, as well as the intellectual and moral education of the nations.

> There exist, indeed, and always will exist, many deplorable things, much suffering, and much wickedness in the world; but it is to the credit of science that, instead of lulling mortals with the feeling of their powerlessness into passivity of resignation, it has urged them to react against destiny, and has taught them the sure way by which they can diminish the sum of woe and injustice, and increase their happiness and that of their fellows. It has not accomplished this by means of verbal exhortations or *a priori* reasoning, but by virtue of processes and words really efficacious, because they are acquired from the study of conditions of existence and the causes of evil.

Further, as the editor of *The Popular Science Monthly* has said:

> The advance of science is evidenced in numberless ways, but our weightiest proof of it is found in the gradual acceptance of enlarged in place of narrower views of the subject. New discoveries are important; the widening of the ranges of research is important; the extension of generalization and better organization of positive knowledge are important; but more important still is the growing general recognition that science is the grand agency in modern times for reshaping the common opinions of the community.

The local elevating effect of work in pure science is the taking a man away from the sordid things of the world, and

> No life can be pure in its purpose, and strong in its strife,
> And all life not be purer and stronger thereby.

By this I would not be understood as placing him who works only in pure science on a pedestal, or intimate that he is superior to the other who makes a practical outcome of his scientific work the main object. I am well aware of the eloquent statements about this being an industrial age and the duty of young men to seek a technological education. Far be it from my purpose to exhibit the least antagonism to the general spirit of such appeals, for I endeavor to teach much of the same thing, but in it all and with it all, I would urge that the pure science be either kept ahead or abreast of commercial progress. Neither the pure nor the practical deserves to be developed alone. They are inter-dependent and have always grown together. The pure research has been utilized later in practise. Industrial demands have stimulated investigation. Illustrations abound. The destiny of nations has been changed by scientific investigations prompted either by search for research sake or by a commercial call. The history of indigo reads like a novel, for chemists have accomplished the task, not of producing artificial indigo, but the genuine indigo by artificial means. The modern spirit of pure science thus elevates man's ideals and that of the applied adds to his comfort, pleasure and happiness.

In advocating Du Bois Reymond's 'Hellenism' or the love of humanistic and scientific culture for its own sake, apart from all considerations of profit and advantage, I would not be understood as

> Nourishing a youth sublime
> With the fairy tales of science.

While I maintain that the dollar should not be the guiding star, there is no objection to dwelling upon the practical value of science; for, as Huxley has said: "It has become obvious that the interests of science and industry are identical; that science can not make a step forward without, sooner or later, opening up new channels for industry; and, on the other hand, that every advance of industry facilitates those experimental investigations upon which the growth of science depends."

It is well understood by those who have knowledge of the problem that the first line

of defense in industrial warfare is the educational centers. We are a great industrious and prosperous nation. Prosperity is the possession 'of enlarging opportunities to secure the gratification of our material, intellectual, social and spiritual wants.'

In the foregoing I have endeavored to show that science is an evolution. In the past, to be sure, at times it has marched with crippled steps; at present it is gripped into the vitals of nations. The modern spirit of science towards religion is sane and healthy; towards literature it leans in offering themes alive and seeking graceful modes for its expression; it fosters and grows with industry, so 'to choke the fountains of science is to dry the source of our prosperity.'

The progress of science among us very largely depends, as Draper has said, on two elements: first, our educational establishments; and second, our scientific societies.

School men within the past decade have learned that it is proper to send the whole boy to school and little by little science has come into the curriculum. There is room for much more sane science and its more widespread teaching, and it should be better taught. Let us teachers then have more to do with pushing the proper recognition of science before the attention of school boards, insisting upon adequate compensation, and let us have men and women ready-equipped for the work. Pardon a personal illustration. I use it solely because I know whereof I speak. Every year there go out from our laboratory at the university a dozen or more graduates who, with rare exceptions, and they are mainly my own assistants, are offered positions in other states. We can change this, and I take it as one of the things this academy may hold out for its accomplishment. How?

We teachers can and must get out and see the schools, confer with the boards, speak to the people, in short, see that wholesome works in science are placed in the libraries, tell of common sense hygiene, assist the great work and create like things to the farmers' institutes, popularize science. There is ' no discredit in popularizing science,' as Mendenhall has said, 'that popularizing what is not science is the thing that is to be shunned and avoided.'

This brings to our immediate attention the instructors in the various institutions that are making the teachers, making the preachers, the lawyers, the doctors, business men and the citizens. Boards of trustees must be made to clearly understand that time and equipment for these things must be had; boards of trustees must be made to understand that the best teachers are those who contribute something to that subject they would have better known and appreciated; boards of trustees must be impressed with the fact that with our present arrangements, most researchers must steal the time necessary from rest, sleep, social concernments and family pleasures and that it is not right, it is not just to make them mere teaching machines.

There is no question whatever but that many of the teachers in our institutions do the treadmill. All of this can not with justice be laid at the doors of our honorable governing bodies, however, for teachers are vain as other mortals. Some insert in catalogues a vast array of special courses, which either are solely for show, or, if they be given, of necessity, can not be with that fresh vigor which should characterize instruction. The man who does that voluntarily loves not really his science. It is far wiser to offer a few courses, give them well and contribute a bit, even a mite, to the sum of knowledge. I do not know but that the late Professor Rowland was a bit severe, yet I wish to quote from an address of his on a 'Plea for Pure Science.' Some chil-

dren may be coaxed, others require whipping.

It is useless to attempt to advance science until one has mastered the science; he must step to the front before his blows can tell in the strife. Furthermore, I do not believe anybody can be thorough in any department of science, without wishing to advance it. In the study of what is known, in the reading of the scientific journals, and the discussions therein contained of the current scientific questions, one would obtain an impulse to work, even though it did not before exist. And the same spirit which prompted him to seek what was already known, would make him wish to know the unknown. And I may say that I never met a case of thorough knowledge in my own science, except in the case of well-known investigators. I have met men who talked well, and I have sometimes asked myself why they did not do something; but further knowledge of their character has shown me the superficiality of their knowledge. I am no longer a believer in men who could do something if they would, or would do something if they had a chance. They are imposters. If the true spirit is there, it will show itself in spite of circumstances.

Your speaker wishes to plead with his southern colleagues for greater activity in research. Many have told me they had no appliances. Liebig had none at first and later bought most of that which he had from his slender stipend; Priestley utilized a lens and the sun's heat and discovered oxygen; Wöhler distilled potassium, using a bent gun barrel as a condenser in Berzelius's laboratory. Where there's a will, there's a way. There is so much unknown, so much to learn, and, as Victor Meyer has said, then there is 'the gaining of gold from rubbish.'

Yes, our equipment is meager; poorer than it ought to be for states now far richer than ever in their history; grown rich, too, as a result of the progress of industries. Science sowed the seed of the present prosperity and it is worthy of remembrance, thanks, reward. And these will come. In a measure, they have come. Every scientific man in the state takes pride in the growth of the new biological building at this institution, the beneficent generosity of a prominent trustee at Trinity College in equipping the physics department, the conduct of the soil survey under the direction of the Department of Agriculture, the Beaufort laboratory, etc.

The importance of promoting science as the duty of the states was well known to the ancients, especially to the Greeks and Arabs. The Prince Consort, in an address before the British Association in 1859, made the following statement:

We may be justified in hoping * * * that the legislature and the state will more and more recognize the claims of science to their attention; so that it may no longer require the begging-box, but speak to the state like a favored child to its parents, sure of his paternal solicitude for its welfare; that the state will recognize in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand.

The endowment of any laboratory in any institution of the state but helps the others. There is no such thing as competition in doing good. The blanket of ignorance may be lifted a bit higher here than there, but each lifts and gives the fresh air of knowledge to those smothering beneath.

So, my friends, in fulfilling the responsibilities begotten of the honor, allow me in closing to give my conception of the destiny of this academy.

Man depends much for his happiness upon the sympathy of those around him; 'it is rare to find one with courage to pursue his own ideals in spite of his surroundings.' So science thrives best where societies exist for its advancement. Science speaks a universal language and knows no geographical, political or social boundaries, otherwise Humphry Davy would never have been so cordially entertained by his French colleagues when the shores of England and France bristled with bayonets in bloody antagonism. Then let us thank God for the brotherhood of science, for

true science, the spirit of modern science, is at war with war. The right spirit of science is that of patient inquiry; of longing for the truth, cost what it may in brain power, energy, money or self-denial; it is the spirit of cooperation as wide as the needs of man; of constructive effort through slow accretions by many laborers in many lands through many years. "The touch of science makes the whole world kin." CHAS. BASKERVILLE.

UNIVERSITY OF NORTH CAROLINA.

DEFLECTION OF THE MISSISSIPPI.

THE theoretical effects of the earth's rotation in deflecting the courses of streams have been discussed by several investigators, among whom are Baines, von Baer, Bertrand, Buff and Gilbert. The deflecting force being persistent and the time during which it acts practically unlimited, the sufficiency of the cause has been repeatedly maintained. So far, however, the discussion has been almost purely theoretical, few actual measurements of relative bank-cutting having been made. This note attempts to present certain qualitative and quantitative data that may have some bearing on the subject. The work was done at Harvard University under direction of Professor W. M. Davis.

The Mississippi River Commission published in 1900 a set of maps which record surveys of two different dates—that of 1883 and that of 1896. The former survey is printed in black, the latter in red. Thus the changes which have occurred in an interval of thirteen years are clearly and accurately recorded and make measurements possible of the relative amounts of right and left cutting.

The part of the river course so surveyed and mapped lies between Rosedale (below Helena, Ark.) and Bayou Goula Bend (below Natchez, La.). It may be divided into two distinct sections. The first lies between Rosedale and Vicksburg and is in that part of the river's course which here swings diagonally across the flood-plain from the bluffs of the Arkansas upland on the west to the bluffs of the eastern upland in Mississippi. The second is between Vicksburg and Bayou Goula Bend, along the eastern side of the flood-plain, where it is rather sharply limited by the bluffs against which the river impinges at ten different places. The two sections are roughly of the same length, when measured along the general course of the stream.

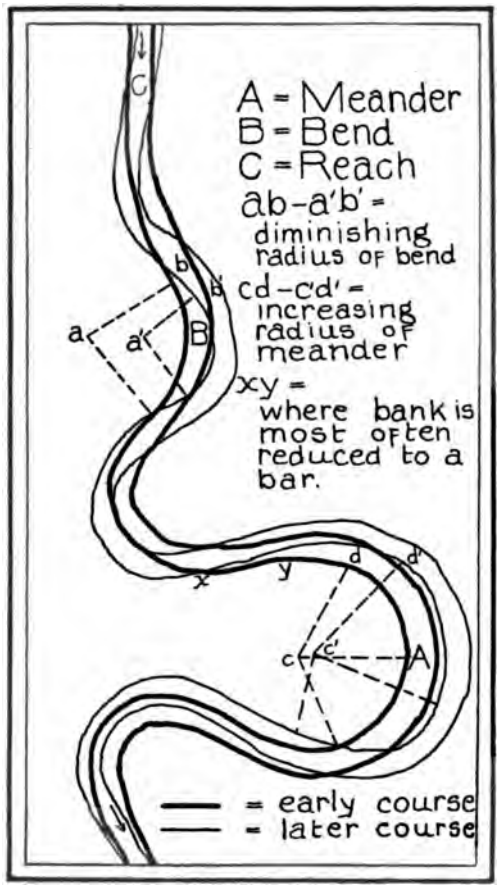
A = Meander
B = Bend
C = Reach
ab-a'b' = diminishing radius of bend
cd-c'd' = increasing radius of meander
xy = where bank is most often reduced to a bar.
= early course
= later course

FIG. 1.

The lowermost part of the latter section—the part lying between Port Hudson and Bayou Goula Bend—has been in recent

years so well defended by revetments that the course has here remained practically unchanged for thirteen years. It is above this point, in that part of the river's course which has not been so completely restrained artificially, that significant results must be looked for. Before presenting the results of my map studies, it is desirable to explain certain terms as illustrated in Fig. 1.

By 'bend' (Fig. 1, *B*) in a river channel is meant a curve whose lateral changes involve a decrease of radius; by 'meander' (Fig. 1, *A*) a curve whose lateral changes involve a steady increase of radius until a cut-off occurs or changes elsewhere in the channel induce a disturbance here. This distinction grew out of the difference in kinds and amounts of cutting at the two sets of curves. It is evident from an examination of the maps and the generalized conditions represented in Fig. 1 that as meanders develop, the relatively straight stretches in the river's course will be continuously shortened and there will be a corresponding increase in the length of that part of the course included within the meanders. As this change progresses the radius of curvature is reduced from infinity to a finite quantity, the reduction continuing until the neck is as small as any other part of the lobe. From this time on the same tendency which ultimately produces a cut-off between alternate meanders operates to the enlargement of the radius of curvature, not only throughout the meander between them, but at the place where a cut-off occurs as well. The ox-bow lakes have for this reason a longer average radius of curvature than an equal number of present meanders. The reaches (Fig. 1, *C*) include those wavering parts of the river's course the further development of which can not be accurately foretold, although it can be shown that the reaches usually develop into bends and the bends grow into meanders. It is in the reaches that there is the greatest difficulty of navigation, islands and bars occurring irregularly, for, lacking a dominant tendency, the energies of the stream are not bent in a relatively permanent and definite direction which would result in a part of the channel being maintained at a somewhat constant depth, as is the case where in consequence of the development of bends and meanders, the threads of the stream pursue a less erratic course.

The following tables contain a detailed list of areas of lateral cutting expressed

TABLE I.

Classified Measurements of Areas Cut on the Right Side and on the Left Expressed in 250ths of a Sq. M. Sheets 13 to 17 Inclusive.

	Left.					Right.				
	Bank.	Bar.	Isl'd.	Bank-bar.	Sub-T.	Bank.	Bar.	Isl'd.	Bank-bar.	Sub-T.
Meanders	2626	432	578	39	3675	3054	473	0	30	3131
Bends	2349	398	126	248	3121	1774	411	131	10	2326
Reaches	492	165	0	107	764	235	441	120	40	1262
Totals	5467	995	704	394	7560	5063	1325	251	80	6719
Sheets 18 to 25 Inclusive.										
Meanders	1943	490	0	90	2523	2378	73	140	102	2693
Bends	1841	453	0	114	2498	2370	189	0	244	2803
Reaches	390	211	60	183	844	1795	70	0	417	2282
Totals	4174	1154	60	387	5865	6543	332	140	763	7778
Gr. Totals (13–25)	9641	2149	764	781	13425	11606	1657	391	843	14497

TABLE II.

LENGTH AND AVERAGE WIDTH OF AREAS CUT EXPRESSED IN 50THS OF A SQ. M.

SHEETS 13 TO 17 INCLUSIVE.

	Left.				Right.			
	Length.		Av. Width.		Length.		Av. Width.	
	Bank.	Bar.	Bank.	Bar.	Bank.	Bar.	Bank.	Bar.
Meanders	212	55	112	53	226	45	98	37
Bends	197	79	106	52	183	55	86	34
Reaches	62	31	41	22	97	63	34	52
Totals	471	165	259	127	506	163	218	123
SHEETS 18 TO 25 INCLUSIVE.								
Meanders	140	50	81	45	188	11	91	11
Bends	235	55	98	43	226	35	156	39
Reaches	104	26	37	25	155	16	83	7
Totals	479	131	216	113	569	62	330	57
Gr. Totals (13–25)	950	296	475	240	1075	225	548	180

in two-hundred-and-fiftieths of a square mile and classified with respect to reaches, bends and meanders in the two sections of the river.

The first column of Table I. gives the amount of bank cutting; the second column the amount of bar cutting. Island cutting is counted right or left, as the island lies on the right or left side of the line of deepest channel. The fourth column gives the amount of cutting involved in changing a bank to a bar. This measurement is necessarily somewhat indefinite. The sub-totals in column five allow easy comparison of cutting in meanders, bends and reaches. The totals, on the other hand, furnish means for rougher comparison, although it is thought that, undifferentiated as totals must always be, it is well to examine the different sets of data separately. By a careful system of checking, the percentage of error in the measurements was found to be but little more than one per cent. Bar-cutting in every case but one is less on the side on which there is the greater bank cutting. In the more finely subdivided records from which the sub-totals in this table were made up, this fact comes out even more strongly. In the bends there is a greater area of bar removed per length of area cut or per length and area of bank removed than is removed in the meanders.

It would seem that the most significant figure in the whole table is 3,054—representing the amount of bank cutting in meanders on the right side of the river. It exceeds the corresponding figure on the left side by more than 16 per cent. It is in this part of the channel that the diverting tendency due to rotation gives its greatest support to the maximum selective influence on velocities developed here under centrifugal force. Moreover, it is in this part of the river's course that the effect of wind-waves in concealing the deflective tendency is least, but a part of a right-handed meander running at right angles to the direction of the prevailing winds. In the bends and reaches (sheets 13–17) the left-handed cutting is in excess, as if the winds here overcame the effect of the earth's rotation.

Although the Mississippi wears its channel as much on one side as on the other, this fact does not contradict the theory of deflection. The direction of flow in the Mississippi is such that any tendency to excess of right-handed over left-handed

cutting may be overcome in part, in whole, or may even be exceeded by the effect of the westerlies on the surface of the stream. If the river flowed north these two forces would combine to produce an effect that might be thought to be greatly in favor of the argument for deflection. In reality it would offer no better example than the Mississippi with its present direction of flow. In the former case the operation of the force would be less visible, but the proof of the existence of the force would be no less clear.

The best examples of deflection in these latitudes must, therefore, be sought among streams flowing neither north nor south, but in the line of the winds—east or west. The deflective tendency will, of course, be as strong under the latter conditions as under the former, while the effect of the westerlies will be distributed over right-handed and left-handed curves alike. When a larger number of measurements of cutting on such streams have been made and the wind effect and deflective tendency

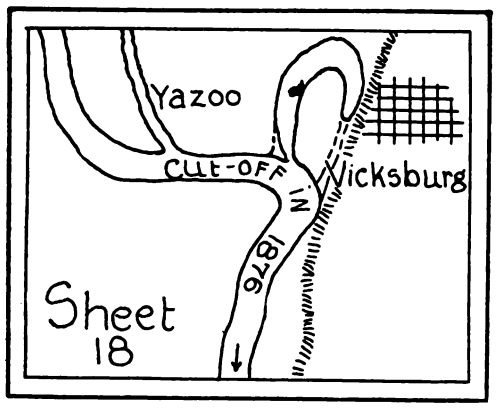

Fig. 2. The Cut-off at Vicksburg.

evaluated, it may be seen that the Mississippi offers as good proof of such tendency as any river we can find. The resolution of forces in such a manner as to produce a negative effect is no less interesting than the resolution of those same forces in producing a positive effect. A volcanic cone gradually and continuously building in mid-ocean at a rate which just counteracts the attack of the sea does not impress the geographer less than the loftier cones of similar origin more favored by position and climatic conditions.

Attention is called to the fact that between Rosedale and Vicksburg there are four cut-offs on the right and an equal number on the left side. Between Vicksburg and Bayou Goula Bend there are five on the right side and but one on the left, and that at Vicksburg, the dividing point between the two sections. This cut-off, as shown in Fig. 2, seems to have been possible only because of the direct way in which the river swings toward the bluffs from its previously free course on the open

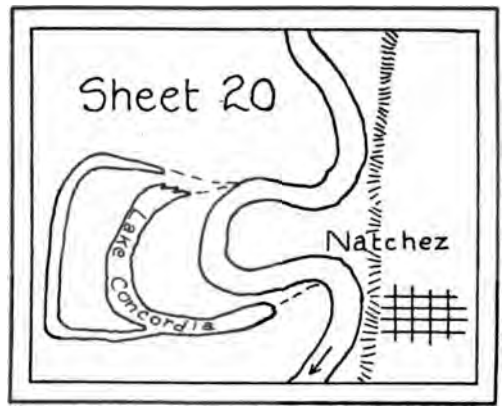

Fig. 3. The Meander and Cut-offs at Natchez showing effects of Restraints exercised by Bluffs on the Right Side of the River.

flood-plain. A bend having developed up-valley from the general course of the stream it was reasonably certain that the river, with the bluffs holding in the current on the left side, should at last pinch off the lobe and produce a cut-off; while farther down stream, where the general course of the river is close to the bluffs, cut-offs are just as certain to occur on the right side.

This restraining influence of the bluffs is brought out in the table. Below Vicksburg the right-handed cutting is notably in excess. Here the number of cut-offs is likewise in excess on the right side of the stream. A typical case of restraint may be seen at Natchez (Fig. 3), where the development of the left-handed curve is hindered while that on the right is free. As a result of these conditions and the down-valley migration of the meanders the river has twice cut through the neck of the lobe and is now increasing the radius of its present curve preparatory to a third cut-off. In stretches which have nothing but free flood-plain on both sides, a right-handed curve could not develop without an accompanying left-handed curve—a fact which can be more readily appreciated when it is remembered that, except for the down-valley movement of the meander as a whole, the center of the growing curve on the open flood-plain is relatively fixed, and the extension and development of sympathetic curves in adjacent parts of the channel are necessary attendants of the growth of the meander.

The foregoing serves to show that on the Mississippi, cut-offs as well as relative bank cutting should be counted as right or left not over the course as a whole but in sections which depend for their individuality, in part at least, upon conditions external to the river and not directly related to deflective tendency.

In conjunction with Professor M. S. W. Jefferson, of the Michigan State Normal College, the writer has undertaken measurements of this kind in Michigan along the River Rouge between its headwaters and Detroit. The river flows to the east through a plain of glacial and lacustrine origin which, on account of its level nature, offers advantages not possessed by the Mississippi. The latter stream, by cutting into a bluff, on one side, and into flood-plain deposits, on the other, does not enable one to use the maps previously mentioned in determining the absolute amount of work accomplished on the two sides of the stream. The areal expression of such cutting is no basis for the determination of the actual amount performed. The river may be doing even more work on the bluffs along its eastern bank than it accomplishes on the western bank. The River Rouge has incised itself in a level plain and in the process of deepening and widening its valley swings against bluffs of the *same* height on opposite sides of the valley.

During the summer of 1903 and in connection with hydrographic work for the U. S. Geological Survey I had the opportunity to examine most of the streams on Long Island with respect to the visible effects of deflection, and although many of the valleys on the south side of the island have a noticeably unsymmetrical development, one bank being steeper than the other, an actual count of the valleys from Montauk Point to Far Rockaway shows such a small majority of valleys asymmetrically developed and with the right bank steeper than the left, that in this case the argument based on deflective tendency does not appear well-grounded. The cuesta-like arrangement of the slopes on the island and the consequent great disparity of stream lengths, velocity and persistence throughout the year, precludes fruitful comparison of valleys on the northern and southern sides of the island as showing in how far the difference in composition of wind force and deflective tendency affects the fashioning of the valley slopes.

ISAIAH BOWMAN.

YPSILANTI, MICH.

SCIENTIFIC BOOKS.

Lehrbuch der Physik; Zweiter Band. Von O. D. CHWOLSON, St. Petersburg; übersetzt von H. Pflaum. Braunschweig, Friedrich Vieweg und Sohn. 1904. Pp. 1056.

The first volume of the German edition of

Chwolson's 'Physics,' covering the general subject of mechanics so far as this is required as an introduction to general physics, was reviewed by the present writer not quite a year ago in SCIENCE. The second volume, covering the subjects of sound and radiant energy, abundantly justifies the very favorable opinion at that time expressed. The author keeps before him a well-defined object, the preparation of a text-book for students, but not a handbook for specialists. The aim is that the student may find what he needs, and also that he may need what he finds. The student's standpoint is continually occupied, though it is assumed that no student would feel prepared to undertake the mastery of such a book in four large volumes without having previously mastered at least the elements of the subject as set forth in ordinary preparatory school work. Nevertheless, in such work it is not uncommon for the elementary student to reach a standpoint that interferes with his subsequent attainment of a comprehensive view. For example, light rays, heat rays and chemical rays are even yet supposed often by beginners to be different in kind, and the gap between these and electric rays is hard to bridge.

Chwolson undertakes the task of setting the student initially on the right standpoint, and of guarding specially against what his experience has shown him to be the most frequent misconceptions. Mathematics is not avoided, but no unnecessary complexities are ever introduced. Indeed, it would be hard to find a book in which good arrangement and accurate statement are attained with so little in the way of mathematical difficulties, though no one need expect to attack any of the problems of physical optics without having to grapple with equations that require thought.

Rather less than the first seventh of the present volume is devoted to the subject of sound. It begins with a chapter on the velocity of propagation of a disturbance in an elastic medium, in which the well-known formula for both longitudinal and transverse vibrations is deduced with unusual simplicity. The last few pages are given to the physical basis of music, which is treated only in outline. In the development of the natural scale the exclusive standard recognized is the French normal $A = 435$, at present adopted as an international musical standard. Now that König is dead, the Chladni standard, $C = 256$, so extensively employed by him for standard forks, may quite probably pass away, as Stuttgardt pitch, $C = 264$, has already disappeared, despite its use by Helmholtz in the 'Tonempfindungen.'

In the introduction to the general subject of radiant energy Chwolson goes at once into an exposition of electric radiation, closing the chapter with an enumeration of five divisions based on wave-length, and with a brief reference to 'neue Strahlen,' the rays connected with the names of Röntgen, Becquerel and Curie. These are still so little known that he does not feel warranted in linking the treatment of them with that of radiations of measurable wave-length.

The phenomena of luminescence are treated as a special transformation of energy quite apart from those of calorific radiation. Specially good and up to date is the discussion of the rate of emission of a black body as a function of temperature and wave-length. The laws of Stefan and Wien are considered, and the conclusion expressed that Stefan's law is thoroughly reliable, but is applicable only to the total radiation of an absolutely black body. The expressions for radiation of special wave-length obtained by Weber, Paschen, Wien, Thiessen, Rayleigh, Planck and Lummner and Jahnke are all considered, and as the result of comparison a preference is expressed for that of Planck (1900). The effect of radiation as pressure upon the surface of an absolutely black body, suspected as long ago as 1754 by DuFay, was first proved experimentally in 1900 by P. Lebedew, whose apparatus is shown and explained. Due credit is given to Nichols and Hull (1901), who have measured this pressure and obtained results that accord well with the requirements of theory. The application to the phenomena of comets is expressed by the statement that the theory is capable of affording a full explanation of the observed forms of comets' tails. E. F. Nichols's great improvements upon the sensitiveness of the

radiomicrometer, and his measurement of the energy radiated from certain stars and planets, are properly acknowledged.

The chapter on optical instruments is excellent. It is followed by one on the eye, which furnishes a satisfactory summary of what is of chief interest in physiological optics to the physicist. This includes a brief discussion of the telestereoscope of Helmholtz, and the more recent double telescope by Zeiss for the perception of a distant object in relief. Interesting developments are the stereo-telemeter, stereo-micrometer and stereo-comparator of Pulfrich. This last instrument finds a new and unexpected field of application to the heavenly bodies. Assume that on two successive evenings photographs of Saturn are taken, using the comparator with camera attachment. During the interval of a day the position of the planet with regard to the stars has changed, as well as the position of the satellites with regard to their primary. Let these two photographs be arranged to form a stereograph and viewed binocularly either with a stereoscope or with the unaided eyes if suitably trained. Against the black background are seen the distant stars. Suspended independently in mid space between foreground and background is the planet. Behind it on one side is a satellite, and on the other side is another satellite just emerging from eclipse. Spatial relations are as distinct as if all were within arm's length. A stereograph of this kind from proofs secured by Wolf at the Heidelberg observatory is one of several that are presented for the reader's scrutiny. The instrument has been applied to the discovery of planetoids, of variable fixed stars, and to the study of such as have considerable proper motion.

The last part of the volume, relating to optical phenomena in the atmosphere, interference of light, diffraction, polarization, double refraction, interference of polarized beams and the turning of the plane of polarization by quartz and other bodies optically active, is well up to the standard of the earlier part. The value of the book is greatly enhanced by the clear cut summaries of important conclusions, and the bibliographic list of references to the literature of the subject with which each chapter is closed.

W. LE CONTE STEVENS.

DISCUSSION AND CORRESPONDENCE.

PALEOZOIC SEED PLANTS.

IN my short note in SCIENCE of July 1 proposing the name *Pteridospermaphyta* for this group of plants, I assumed that all interested in the subject were acquainted with the facts and the literature, and I expressly refrained from entering into details. It seems that I was mistaken in this assumption, otherwise I could hardly have been misunderstood.

When in 1897 Potonié founded the group Cycadofilices,* he based it on the internal structure and classed it under the Pteridophyta with the same rank as the Filices. It included *Nœggerathia,* the Medullosæ, *Cladoxylon, Lyginopteris, Heterangium* and *Protopitys.* Later he worked the same subject over for Engler and Prantl's 'Natürliche Pflanzenfamilien.'† He here says that the groups Sphenopterides, Percopterides and Neuropterides might perhaps be better included in the Cycadofilices, although he continues to class them with the ferns. He now includes *Calamopitys* in this group. M. R. Zeiller in 1900‡ discussed these forms, and although he admitted that the characters then known approached more closely those of cycads than of ferns, he says it would be rash to exclude them from the latter on these characters alone, that they may represent a special type of Filicineæ, provided with secondary wood, and that indications of fructification observed on certain fronds of *Alethopteris, Odontopteris* and *Neuropteris* may be adduced in favor of this hypothesis.

In the first preliminary paper of Drs. Oliver and Scott§ they show that *Lyginodendron,* which Potonié classes in the Lepidodendraceæ,

* 'Lehrbuch der Pflanzenpalaeontologie,' p. 160 (Lief, 2, dated 1897).

† Teil I., Abt. 4, pp. 780–795 (Lief. 213 dated 1902).

‡ 'Eléments de Paléobotanique,' pp. 124 ff., 370.

§ 'On *Lagenostoma Lomaxi*, the seed of *Lyginodendron*,' *Proc. Roy. Soc.*, Vol. LXXI., pp. 477–481.

almost certainly bore the seeds called *Lagenostoma Lomaxi* by Williamson. Toward the close of this paper they make the following significant remark: "It is not likely that *Lyginodendron* stood alone in this; we must now be prepared to find, what has long been recognized as a possibility, that many of the plants grouped under Cycadofilices already possessed seeds, and thus that a considerable proportion of the so-called 'fern-fronds' of the Palæobotanist really belonged to Spermatophyta."

Following quick upon this discovery came that of Mr. Kidston of a specimen of *Neuropteris heterophylla* bearing a rhabdocarpous seed.* The second preliminary paper of Drs. Oliver and Scott† does not mention Kidston's discovery, but deals, like the first, with the seed of *Lagenostoma Lomaxi*. In this paper, however, they say: "There are many indications that other genera, now grouped under Cycadofilices, had likewise become seed-bearing plants. It is proposed to form a distinct class, under the name Pteridospermæ, to embrace those Paleozoic plants with the habit and much of the internal organization of ferns, which were reproduced by means of seeds. At present, the families Lyginodendreæ and Medulloseæ may be placed, with little risk of error, in the new class, Pteridospermæ." Putting this with the remark above quoted from their previous paper, it seems clear that this new class is regarded as belonging to the Spermatophyta as coordinate with the Gymnospermæ and Angiospermæ.

In a paper presented to the Paris Academy of Sciences by M. Grand'Eury on March 7, 1904,‡ he mentions the numerous seeds found associated with the Neuropterideæ and gives his reasons for believing that they were borne by those plants, and he remarks that 'from all this it evidently does not follow that the Neuropterideæ are primitive Cycadineæ, but this solution is the more probable as the stipes of these ferns resemble in a striking manner *Colpoxylon* and *Medullosa*.'

* *Op. cit.*, Vol. LXXII., December 29, 1903, p. 487.

† *Op. cit.*, Vol. LXXIII., pp. 4–5.

‡ *Comptus Rendus*, Vol. CXXXVIII., pp. 607–610.

At the next session of the academy (March 4), M. R. Zeiller made a communication on the mode of fructification of the Cycadofilicineæ. Commenting on the facts set forth by Grand-'Eury and the discoveries of Kidston and Oliver and Scott, he says: "We thus find ourselves in the presence of types manifestly related on the one hand to the ferns, on the other to the Cycadineæ, and we can hardly refuse to see in this group of the Cycadofilicineæ or Pteridospermæ, to use the name proposed by MM. Oliver and Scott, one of the principal steps in the process of evolution which must have led from the one to the other; but we have already to do here with true Gymnosperms, and the establishment of this fact leads to a profound modification in our knowledge of the Carboniferous flora.*

Still more significant are certain statements made by M. B. Renault relative to the Paleozoic flora of Autun in a paper presented to the academy on May 16, 1904. He says: "With the stems of *Calamodendron* and *Arthropitys* and their branches we have met with small cylindrical seeds several millimeters long (Stephanospermum); the proximity of the seeds and branches may permit the assumption of some relationship (*parenté*) between them. * * * From the facts above set forth it seems to follow that the Cryptogams may have had several points of contact with the Phanerogams; the Colpoxylons remind us of the Cycads and Ferns; *Arthropitys* of the Equisetaceæ and the Conifers; and finally the seeds of *Gnetopsis* recall those of the Gnetaceæ.†

M. Grand'Eury returned to this subject in the session of July 4, 1904, and gave reasons for believing that several of the genera formerly regarded as ferns, including *Linopteris*, were seed-bearing, and that the small striate seeds associated with *Neuropteris flexuosa* from the Department of the Gard were borne by that species. He entered somewhat into the discussion of the numerous

* *Comptes Rendus*, Vol. CXXXVIII., p. 664.

† *Comptes Rendus*, Vol. CXXXVIII., p. 1239. This paper was republished in the *Procès-Verbaux de la Société d'Histoire naturelle d'Autun*, Année 1904.

seeds that have been found at St. Etienne and in other parts of France, and the probable connection of a considerable portion of them with these fern-like genera.*

About the last work done by Adolphe Brongniart was the elaboration of the collections of these silicified seeds, the results of which were published posthumously in a large monograph.† In the light of recent discoveries this work assumes special importance. From such an examination as I was able to make in 1900, in company with M. Potonié and under the guidance of M. Grand'Eury, of the beds of St. Etienne, from which most of these seeds were obtained, I conclude that it is doubtful whether any will be found there attached to stems or fronds, but some may be so found, and, as we have seen, they are being so found in other places.

These and other considerations which need not be introduced here have led me to the conclusion that the plants in question should not be classed either as Pteridophyta or as Spermatophyta, but should be regarded as constituting a distinct phylum intermediate between the two, for which I proposed the name Pteridospermaphyta. The three great types to which the Paleozoic seed plants, exclusive of recognized Gymnosperms, either have proved or are likely to prove to be allied are the Ferns, the Calamites and the Lepidophytes. It therefore seems probable that there will need to be recognized three corresponding classes, which should be called, respectively, the Pteridospermæ, the Calamospermæ and the Lepidospermæ. The first of these names has already been appropriately used, unless, as Potonié's classification of *Lyginodendron* in the Lepidodendraceæ would imply, that plant has its closest affinities with the Lepidophytes. In that case it would belong to the class Lepidospermæ. Those having affinities with the Calamarians or Equisetineæ, such as the Stephanosperma, believed to have been borne by *Calamodendron* or *Arthropitys*, would belong to the class Calamospermæ, while those seeds borne by plants having the foliage of ferns, such as *Neuropteris heterophylla*, would belong to the class Pteridospermæ.

If it be said that the existence of seeds necessarily places a plant in the Spermatophyta, the answer is that at the stage in plant development to which those forms belonged it will not probably prove possible to maintain any such sharp line of demarkation. The distinction between microspores and pollen has already practically broken down, and Kidston now regards the spores of *Neuropteris heterophylla* as the male inflorescence. In like manner the distinction between macrospores and seeds is likely to break down, and the attempt to retain plants of such low organization in the Spermatophyta will present grave difficulties. By establishing an intermediate phylum to which all forms may be referred as fast as the appropriate parts are discovered, all these difficulties will be removed. We should then have the following classification of vascular plants:

PHYLA.	CLASSES.
Pteridophyta	Filicineæ.
	Equisetineæ.
	Lycopodineæ.
Pteridospermaphyta	Pteridospermæ.
	Calamospermæ.
	Lepidospermæ.
Spermatophyta	Gymnospermæ.
	Angiospermæ.

LESTER F. WARD.

THE SOUFRIÈRE OF ST. VINCENT IN JULY, 1904.

TO THE EDITOR OF SCIENCE: When the report was circulated in the daily papers of this country that Mont Pelé was in full eruption again, May 8, 1904, the second anniversary of the destruction of St. Pierre, the author wrote to correspondents in Martinique and St. Vincent for particular information as to the condition of the volcanoes which roused so much attention throughout the world two years ago. The data regarding Mont Pelé were published in SCIENCE for July 1, 1904.*

From St. Vincent comes the statement that everything has been quiet at the Soufrière since the great eruptions in the latter part of

* *Comptes Rendus*, Vol. CXXXIX., pp. 23–27.

† 'Recherches sur les Graines Fossiles Silicifiées,' par Adolphe Brongniart, Paris, 1881, fol. with 21 plates, many colored.

* Hovey, 'Mont Pelé from October 20, 1903, to May 20, 1904,' SCIENCE, N. S., Vol. XX., pp. 23–24.

March, 1903. The present condition of the volcano is shown by the following extract from a letter to the author written July 13, 1904, by Rev. Thomas Huckerby of Château Belair, St. Vincent:

The general condition of things is far different from what it was twelve months ago. At the present time there is very little emission of steam from the fissures which formed themselves in the ejecta left inside the crater after the last eruption. The surface of the lake is gradually widening, which result is brought about by the falling down of the ashy sides of the immense bowl. Large quantities of material from the top of the perpendicular windward side are falling in, which cause will ultimately bring back the gradual declivity of former years. I should say that the crater, from east to west, is considerably over a mile in diameter. There is still a very strong smell of sulphuretted hydrogen, which at times is perceptible at Château Belair. It is surprising to find that much of the vegetation especially near the base of the mountain has survived through all the adverse circumstances of the past two years; even the maroon tree is throwing out shoots from its battered and charred roots. The mongoose has found his way back to a point above the Half-Way Tree. I think that we may with safety conclude that the god Vulcan has quietened down to another period of rest as far as St. Vincent is concerned.

Mr. Huckerby also forwards a photograph of the interior of the crater which indicates not only a widening of the lake due to the falling in of the walls, but also a rise due to the accumulation of water. It is evident that the mountain is rapidly resuming its former condition and appearance under the influence of the agencies which tend towards the rapid decomposition of rock material in the tropics.

Edmund Otis Hovey.

American Museum of Natural History,
August 4, 1904.

SPECIAL ARTICLES.

THE INHERITANCE OF SONG IN PASSERINE BIRDS.

Further Observation on the Development of Song and Nest-building in Hand-reared Rose-breasted Grosbeaks, Zamelodia Ludoviciana (Linnæus).

In a paper published in Science, June 24, 1904,* I have recorded some observations in regard to the growth, plumage and song of hand-reared rose-breasted grosbeaks. It is the purpose of the present paper to carry these observations a step further and to describe what occurred to the birds after they were mated, as recorded in the foregoing paper.

About the third week in May, 1904, the song of the two male birds, each of which now had a mate, became crystallized and assumed a definite character, which was almost alike in both, but was absolutely and entirely different from the song of the rose-breasted grosbeak as it is heard when wild out of doors. I have had for some years in a cage one of the green bulbuls of India, known as Hardwick's bulbul, *Chloropsis hardwickii*, Jardine & Selby. This bird is singularly persistent in singing for about nine months in the year. It is a male. My two pairs of rose-breasted grosbeaks were in a cage adjacent to that of the bulbul, and by the middle of May of the present year the songs of the two male grosbeaks were so closely an imitation of the insistent song of the bulbul that it was difficult, when not looking at the birds, to tell which species was singing. I may say that the song of the green bulbul is emphatic, clear, high-pitched, rather melodious and delivered so that the whole does not occupy more time than does the song of the song sparrow, which, in a certain way, this song resembles. The song of the rose-breasted grosbeak as heard in wild birds I should describe as being like that of the robin, but more melodious and richer, and uttered with much greater deliberation. It will be perceived that the contrast between this kind of song and that of the bulbul is great. This song was constant and of daily occurrence throughout the last ten days of May and the whole of June, but ceased and was given up entirely by July 4.

During the whole of May (the pairs having mated and being in different cages), the process of mating, and later the matters of nest-building and laying were carried on as I shall now set forth. After much preliminary courting on the part of the males, which was accompanied by some severe quarrels between the mating birds, they finally became paired. These quarrels were at times so severe that it was essential to separate the birds for periods

* Science, N. S., Vol. XIX., No. 495, pp. 957–959, June 24, 1904.

of greater or less time. The strange female which I introduced to one of the males had to remain for several weeks in a small cage inside of the larger cage in which the male was confined in order to prevent the sanguinary quarrels in which the birds engaged. At times one would be the victor and again the other; but generally it was the male bird that was triumphant. The victor in every case so bullied and annoyed the vanquished that the life of the conquered birds was, for the time, rendered miserable. However, all this was remedied by time and the birds came ultimately to a satisfactory understanding.

About the middle of May it was evident that they wished to build nests; any straw or stray feather in the bottom of the cage was eagerly taken and attempts were made to place such material in some secure position. I now put branches in both of the cages, with what I considered suitable forks in which the birds might build the characteristic nests of wild grosbeaks. I also placed in the cage rootlets, straw, small sticks and twigs, in short, as nearly as I could, the same material that I found in the nests of wild rose-breasted grosbeaks. These the birds eagerly availed themselves of and for ten days or more engaged themselves most busily in abortive attempts at nest-building. They seemed unable to arrange a suitable foundation of rootlets and twigs in any of the crotches or branches I had given them, and after this thing had gone on for two weeks and no progress had been made, I determined to give them artificial nests. These were the kind of nests supplied to canary birds, being wire baskets of fine mesh into which a felting of cowhair was securely sewed.

In both cases the grosbeaks availed themselves of these nests at once and proceeded to utilize feathers and some extra cowhair that I had given them to complete the lining of the structure. In four days after receiving these nests both females began to lay; but, though each female laid a full complement of eggs, these were generally broken by the birds. The first three or four eggs laid had hard shells and after that each of the females laid several eggs with soft shells. The way that I account for the eggs being broken is that both birds of each pair, after an egg had been laid in the nest, continued their efforts to build a structure more to their liking, and that it was their claws as they trampled about that perforated the shell of the eggs already laid.

After the first laying which I have described as abortive, an interval of perhaps a week intervened, when laying began again with almost precisely the same results. All this time the males were constantly singing, courting the females, feeding them, caressing them, and the operation of treading was frequently witnessed throughout the day.

While I am not prepared to conclude that the grosbeaks would not have built a nest, if furnished with more commodious quarters and nearer like the condition of affairs that exist out of doors, I conclude that so far as nest-building in cages is concerned they are unable to accomplish anything. So far as the song is concerned I believe that they inherit the call-notes of both pleasure and fear, but that the song of the males was an imitation of the song of a bird that strongly impressed them during the period when they were cultivating this secondary sexual characteristic.

WILLIAM E. D. SCOTT.

PRINCETON UNIVERSITY,
August 8, 1904.

CURRENT NOTES ON METEOROLOGY.

UTILIZATION OF FOG.

IN the *Monthly Weather Review*, XXXII., No. 4, 1904, the suggestion is made by a writer in San Diego, Cal., that an instrument consisting of a wire frame-work be contrived, which shall collect fog particles, conduct the drops into a rain-gauge, and thus make the measurement of fog possible. The object of this measurement would be to show that in such a region as southern California, where the rainfall is small and where there is a good deal of fog, the fog deposit is a considerable one, and is of noteworthy importance to vegetation. In his comments on this suggestion, Professor Abbe rightly points out that it would be difficult, if not impossible, to argue from the catch of a fog screen to the catch of an orchard of trees; that the 'fog depositor'

would give no positive information as to how much the leaves and stems of plants collect, or how much of the water falls to the ground in such a way that the roots of the plants may utilize it, and that the chief benefit which delicate plants on the California coast obtain from the fogs is probably in the protection which the fogs afford against the heat of the sun.

CLIMATE OF SOUTH AFRICA.

J. R. Sutton, meteorologist of the DeBeers Consolidated Mines at Kimberley, South Africa, has published a paper on 'The Determination of Mean Results from Observations made at Second-Order Stations on the Tableland of South Africa' (*Rept. So. Afr. Assoc. Adv. Sci.*, Vol. I., April, 1903). The observations in Cape Colony are usually made at 8 A.M., Colony mean time, but other hours are used at other stations. It was in order that all these observations may be compared with one another that the present paper was prepared. The author has taken the observations at Kimberley, which are very complete, and has calculated from them the corrections which are needed in order to reduce the hourly means of all elements to the true means for each month and for the year.

CLIMATE OF SIERRA LEONE.

That Sierra Leone has some right to the unenviable title of 'the white man's grave' is evidenced by the fact that in the nineteenth century no less than eighteen governors or acting governors of the colony died at their posts or on their way home. This fact is brought out in a recent book on Sierra Leone by Major J. J. Crooks, who was governor at three different times ('A History of the Colony of Sierra Leone, Western Africa,' 1903). Major Crooks admits that 'in spite of sanitary arrangements now in force' the climate 'can not be said to improve greatly.'

THUNDER-STORMS AND PRESSURE.

A. J. Monné, the editor of the new Dutch meteorological journal, *Hemel en Dampkring*, has recently discussed the question of the frequency of thunder-storms under different conditions of pressure, and finds that (in Holland) thunder-storms occur most frequently when the pressure is slightly below the normal. Similar conclusions have also been reached by Prestel and Prohaska. It should, however, be noted that mountain thunder-storms often occur locally during hot, clear, anticyclonic days, when the pressure is high.

SIROCCO IN TUNIS.

Hann calls attention (*Met. Zeitschr.*, 1904, 44–45) to a temperature of 104.9° Fahr. registered at 9 P.M., August 27, 1902, at the meteorological station in Tunis. This remarkably high reading was made during a sirocco. The relative humidity at the same time was five per cent. The sirocco was accompanied by a fall of fine red dust and a few drops of warm rain.

BIRD MIGRATION IN ENGLAND.

Studies of the migration of birds made at the Kentish Lightship, in the English Channel, in the autumn of 1903, by Mr. Eagle Clarke, show that the immediate cause of the great migratory movements was a fall of temperature in the area of origin. When this fall occurs, the instinct to migrate appears to be suddenly aroused, and the movement takes place even under the most unfavorable meteorological conditions. The direction of the wind appears to have no influence.

THE WIND.

'Le Vent dans l'Antiquité' is the title of a paper by F. Hooreman, in *Ciel et Terre* for July 1, which may be of interest to many readers who are not especially concerned with meteorology. The subdivisions of this discussion are: Ancient theories regarding the origin and nature of wind; names of the winds; climatic characteristics of winds; the tower of the winds at Athens.

R. DeC. Ward.

Harvard University.

A STATION FOR THE STUDY OF BIRD LIFE.

Articles of incorporation have just been drawn looking to the establishment on a permanent foundation of the 'Worthington Society for the Investigation of Bird Life.' The

founder, Mr. Charles C. Worthington, will erect and endow, on his estate at Shawnee, Monroe County, Pennsylvania, the necessary buildings and equipment.

The Worthington Society will have for its purpose the consideration of bird life as it is found in nature, and will also have many birds under confinement for study and experiment.

The following is a summary of the chief topics that will present an immediate field for experimentation, which it is proposed by the liberality of the foundation to make continuous and exhaustive in the hope of reaching conclusive results.

1. The study and consideration of a bird as an individual. It is believed that by means of observation carried through the entire life of the individual, with a daily record, brief or elaborate, as exigencies may require, much will be learned regarding matters that are now obscure. Facts, such as growth, habits, health, temper, etc., will be daily reported.

2. The study of the occurrence, extent, nature and cause of variations in different representatives of the same species.

3. Changes in color and appearance correlating with age, sex and season.

4. Changes in color and appearance due to light, heat, presence or absence of moisture, and to food. How rapid a change in appearance can be effected by a new environment or a new set of conditions?

5. Heredity. What general characteristics are transmitted? Are acquired characteristics transmitted? The consideration of atavism, prepotency and telegony.

6. Experiments in breeding. Hybridity and the fertility of hybrids. The possibility of establishing a new physiological species.

7. Experiments in change of color due to moult.

8. Adaptability. The plasticity of animals. How great a factor is this in domesticating new kinds of animals?

9. The leisure of animals. How is this acquired? Being acquired, how is this employed?

10. Instinct, habit and the development of intelligence.

11. The possibility of breeding insectivorous and other beneficial kinds of birds to restock a given region or to increase native birds, as has been done in the case of fish, by the United States Fish Commission.

A temporary laboratory and aviary is being equipped, and preliminary work will begin with the installment of a large number of native and foreign birds early in September. Mr. Worthington has procured the services of Mr. William E. D. Scott, Curator of the Department of Ornithology at Princeton University, as director of the proposed work. Mr. Bruce Horsfall has been engaged as chief assistant and artist. The corps of assistants and workers will be increased as the plans of the Worthington Society develop.

SCIENTIFIC NOTES AND NEWS.

DR. S. WEIR MITCHELL, of Philadelphia, has been elected a corresponding member of the Paris Academy of Medicine.

DR. WILLIAM OSLER, professor of medicine at the Johns Hopkins University, has been appointed regius professor of medicine at the University of Oxford in the place of Sir John Burdon-Sanderson. *The Medical Record* says: "This news will be received with deep regret by a host of friends and admirers of Dr. Osler in this country, who have long looked on him as one of the leaders in American medical thought. Dr. Osler has passed all his professional life as a teacher of medicine, a vocation for which he is eminently qualified by his broad culture, profound medical learning, and an inborn gift of expression. He was born in Tecumseh, Ontario, in 1849, and was graduated in medicine from McGill University, Montreal, in 1872, For ten years, from 1874 to 1884, he was professor of the institutes of medicine at McGill, from 1884 to 1889 he was professor of clinical medicine at the University of Pennsylvania, Philadelphia, and since 1889 he has held the chair of medicine at the Johns Hopkins University, Baltimore. We beg to offer our congratulations to the new regius professor of medicine at Oxford, and at the same time to send anticipatory greetings to Sir William Osler, Bart. The Oxford School of Medicine is also and especially to be congratulated."

THE Department of Agriculture at Washington is making definite arrangements concerning the work which will be carried on with the Guatemalan ants found by Mr. O. F. Cook in Guatemala to kill the cotton boll weevil. Mr. Cook has been assigned to the Bureau of Entomology for especial work on the ant, although he is to continue the personal direction of the work in tropical agriculture by the Bureau of Plant Industry. He has authority under the chief of the Bureau of Entomology to carry to completion the study of the life history of the Guatemalan ant and of such other species of ants as may be involved in order to properly understand the life history of this species. He will also direct and superintend the further introduction of the *kelep* ant from Guatemala if the same is deemed necessary, and will supervise and carry out the work connected with the colonization of the ant in the southern United States. All publications on the work will be issued by the Bureau of Entomology. Cooperation with the Bureau of Plant Industry will continue in so far as such cooperation may be useful in the utilization of the ant in practical cotton culture and in incidental studies on the varieties of cotton best adapted to support the ants, and other collateral considerations which involve problems of plant life history, plant introduction, plant breeding and plant pathology. Results of any such collaboration, where they have a botanical or plant industry bearing, are to be published by the Bureau of Plant Industry.

UNTIL such time as a successor to the late Dr. J. B. Hatcher, as curator of paleontology in the Carnegie Museum, shall have been chosen, the work of the Section of Paleontology in that institution will be under the immediate supervision of Dr. W. J. Holland, the director of the museum.

THE University of Freiburg has conferred an honorary doctorate on the anthropologist, Otto Ammon, of Karlsruhe.

PROFESSOR BLONDLOT, the physicist of Nancy, has been made an officer of the French Legion of Honor.

The British Medical Journal states that Professor von Esmarch, of Kiel, who recently celebrated his eightieth birthday, who was recently the victim of an accident which disabled him for a time, has now recovered and is able to take his customary walks in the environs of the town.

PROFESSOR EWALD HERING, the well-known physiologist, celebrated his seventieth birthday at Leipzig, on August 5.

DR. GEORG THILENIUS, professor of anthropology at Breslau, has been appointed director of the Hamburg Museum of Ethnology.

THE British Admiralty has appointed a standing committee on machinery designs, with Professor A. B. W. Kennedy, LL.D., F.R.S., as president.

THE Royal College of Physicians, London, has appointed lecturers for next year as follows: The Goulstonian lecturer, Dr. W. C. Bosanquet; the Milroy, Dr. T. M. Legge; the Lumleian, Dr. W. H. Allchin; the Oliver Sharpey, Dr. L. E. Hill; the FitzPatrick, Dr. Norman Moore.

WE learn from *Nature* that a statue to Jan Pieter Minckelers, the reputed discoverer of coal gas, was unveiled last month in Maastricht, Holland. Minckelers was born in 1748, and became in 1772 professor of physics in the University of Louvain, where in 1784, in endeavoring to discover a substitute for hydrogen, he succeeded in obtaining from the distillation of powdered coal a gas which he called 'inflammable air.' It was in 1785 that he first utilized the gas for lighting purposes, when a class-room in the Louvain University was illuminated by his method. He died in 1824 at the age of seventy-six years.

DR. JOSEPH DAVID EVERETT, F.R.S., formerly professor of natural philosophy at Queen's College, Belfast, died on August 9, at the age of seventy-three years. In 1871 Dr. Everett moved the appointment of a committee of the British Association for the selection and naming of dynamical and electrical units, and in 1873 drafted a report in which the terms 'dyne,' 'erg,' and 'C. G. S. unit' were introduced at his suggestion. His 'Illustration of

the C. G. S. System' was translated into many languages.

THE deaths are also announced of Professor Karl Weigert, director of the Laboratory of Pathological Anatomy of the Senckenburg Foundation, Frankfort on Maine, well-known for his important contributions to histology; of Dr. Friedrich Eisenlohr, associate professor of mathematics at Heidelburg, on July 21, aged seventy-three years; of Dr. Lobry de Bruyn, professor of chemistry at Amsterdam, on July 22 at the age of forty-seven years; of M. Jean Gabriel de Tarde, the author of well-known works on social psychology, at Paris at the age of sixty-one years, and of M. Robert Bieri, aged twenty-six years, recently appointed professor of natural sciences at the Berne Normal School, who was killed by an Alpine accident on August 4.

WE call attention to advertisements in SCIENCE announcing that applications are invited for the professorship of geology and mineralogy in the University of Melbourne and for the post of assistant entomologist in the Department of Agriculture, Cape Colony.

THE annual meeting of the Association of German men of science and physicians will be held at Breslau, from September 18 to 24.

THE Sixth International Congress of Zoology met at Berne from August 14 to 19. When the preliminary program was issued in July 250 members had joined the congress and 70 papers had been placed on the preliminary program. Among the papers was a discussion on recently discovered stages in the evolution of the horse and contemporary mammals in North America, opened by Professor H. F. Osborn; a paper on changes of animal cells during youth and old age, by Professor Charles S. Minot, and on peculiarities in the development of Chimaera collici, by Professor Bashford Dean.

THE Society of Chemical Industry will meet in New York, from September 7 to 12, under the presidency of Sir William Ramsay, who will give his address at Columbia University on September 8. About one hundred British members will attend the meeting. After the adjournment in New York a tour has been arranged ending at St. Louis on September 19 in time for the Congress of Arts and Science.

THE British Medical Association will meet next year in Leicester, under the presidency of Mr. G. C. Franklin. The meeting in 1906 will probably be in Toronto.

THE twelfth National Irrigation Congress will be held at El Paso, Texas, from November 15 to 18. The congress will meet in four sections, the names of which indicate that attention will be paid to popular interests. They are: 'Save the Forests,' 'Store the Floods,' 'Reclaim the Deserts' and 'Homes on the Land.'

IT is stated in *Nature* that a board of agriculture has recently been established in the Bahamas, and a botanic station is to be started in connection with it for which a curator will be required. Applications for the post should be made in the first instance to the Imperial Commissioner of Agriculture for the West Indies, Barbados.

THE field parties sent out by the Carnegie Museum in the spring in order to make paleontological collections report unusual success in the field. The party operating in Montana has succeeded in finding some valuable specimens of Triceratops. Good collections have been made in western Nebraska, and the collections of invertebrates made in New York and Canada are extensive.

INVESTIGATIONS carried on during the last year by Mr. S. W. McCallie, assistant state geologist of Georgia, acting in cooperation with the United States Geological Survey, have revealed the presence of interesting and perhaps valuable properties in some of the artesian waters in the Coastal Plain of that state. Water taken from a deep well at Baxley showed on analysis 5.5 parts per 1,000,000 of phosphoric acid, which would indicate that it might be used for fertilizing as well as for irrigating barren fields. In other words, it may be acceptable to the desert land as both food and drink. It is estimated that a layer of this phosphoric acid-bearing water 12 inches deep over one acre of land would exert a fertilizing effect equal to that of 200 pounds of commercial fertilizer.

UNIVERSITY AND EDUCATIONAL NEWS.

THE New York *Evening Post* states that a canvassing committee of the alumni of the Massachusetts Institute of Technology has been formed, in connection with a plan to raise an endowment fund. It is said that $1,500,000 already has been pledged, and that every one of the thirty-seven classes graduated from the institute will be organized to contribute annually a certain fixed sum. The purpose is to make the institute independent financially, and thus check the movement for a union with Harvard.

THE Drapers' Company have discharged the debt of University College, London, to the bankers to the amount of £30,000. The treasurer has received from Messrs. Wernher, Beit and Co. their check for £10,000, promised to promote the incorporation of the college in the university. For the completion of the incorporation scheme, there remains the sum of £18,000 to be raised.

The Medical Record states that recently several foreign missionary societies in this country and England agreed to establish jointly a school of high rank in China for the instruction of natives in the principles of modern medicine and surgery. In accordance with the scheme a medical college is now under construction. The cost is estimated at $50,000. Toward this the Dowager Empress has contributed about $6,000. Subscriptions are now being sought from high Chinese officials, who are expected to follow the example of the Empress. There will be a five-year course, and the school will have authority to confer the degree of doctor of medicine upon students who complete this course and pass the examination successfully. The training will be regardless of creed, but the bulk of the students at first will naturally be christians.

THE total number of matriculated students during the present summer at the German universities is 39,581, against 37,881 last winter and 37,813 during the summer of 1903. Ten years ago the attendance was about 11,000 less than to-day. Eleven thousand seven hundred and seventy-five of the present students study law, 8,111 philology and history, 5,945 medicine, 5,945 mathematics or natural sciences, 2,235 evangelical theology, and 1,770 Catholic theology.

THE Seminary for Oriental Languages at Berlin has, during the present summer course, 156 students. Of these, 70 are jurists, 45 are candidates for the diplomatic and consular service, 29 are scientists, teachers and members of the philosophical faculty, 18 are Government officials, merchants and private persons, 19 are officials of the Federal post-office department, 13 are army officers, 2 are physicians, 3 are theologians, and 2 are technicians. The number of foreigners is 10.

PROFESSOR A. MARSTON has been appointed dean and G. W. Bissell, vice-dean of the Division of Engineering of the Iowa State College, both retaining their chairs as heads of their respective departments. Professor L. E. Ashbaugh has been appointed associate professor of civil engineering and W. M. Wilson, assistant professor of mechanical engineering. A new assistant professorship of electrical engineering has been created, but the position is as yet unfilled. The last legislature has established an Engineering Experiment Station for which the trustees have appointed the following staff: A. Marston, director; G. W. Bissell, L. B. Spiney, S. W. Beyer, W. H. Meeker and the president of the college, Dr. A. B. Storms, *ex-officio*. Last year's enrollment in the engineering division of the college was 675.

DR. H. B. TORREY has been promoted to an assistant professorship of zoology at the University of California.

J. BURT MINER, Ph.D. (Columbia), has been appointed instructor in philosophy in the University of Iowa.

THE managers of the Philip Walker Fund have elected Mr. J. Henderson Smith, B.R., Balliol College, of Oxford University (M.B. Edin.), to the Philip Walker studentship for three years. This is the first election to the studentship, which has only been founded during the past year for the furtherance of original research in pathology.

BARON VON EISELBERG, professor of surgery in the University of Vienna, has declined an invitation to succeed Professor König in the corresponding chair at Berlin.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 2, 1904.

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THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE.

THE widespread interest in the International Congress of Arts and Science, to be held at the St. Louis World's Fair from the nineteenth to the twenty-fourth of September, may justify a word concerning the latest stages of its development. SCIENCE has carefully sketched its beginning and its growth. Full discussions characterized the uniqueness of its plans and purpose and the scientific aims which are so different from the usual congresses with their disconnected programs and their lack of unity. These papers showed that the congress was to be controlled by the single purpose to work towards the unity and inner relation of knowledge; and that its program was a complete whole whose parts were in closest relation. The whole range of sciences is embraced, while the entire field was divided into twenty-four departments and these into one hundred and thirty sections. The addresses to be prepared by invited speakers are to deal in all departments alike with the inner unity and with the fundamental conception and methods, and in all sections alike with the interrelations to the neighboring sections and with the leading problems of the day. The discussion of the whole plan was followed in SCIENCE by reports with regard to the actions of the organizing committee that, under the leadership of Professor Newcomb, the president of the congress, secured the cooperation of leading specialists abroad. And, when at the beginning of June the list of chairmen and official speakers was completed and

published, SCIENCE reprinted the imposing list of participants for those departments which stand nearest to the interests of the magazine.

Since the program with the names of the hundred and sixty departmental and sectional chairmen and the three hundred and twenty official speakers has been published, only a few changes and additions have occurred in that part of the preparations. To be sure, some of the foreign speakers were obliged to withdraw at this late hour, but in most cases the cable filled quickly the vacancies with well-known substitutes from the same countries. In two or three cases two sections have been fused into one in accordance with special wishes. The few positions of chairman which appeared still vacant in the printed program have since been filled; the chairmen are without exception Americans. Among the speakers about a third are foreigners, representing all countries important in scholarship. Even Japan fills four important places. Canadians and Mexicans are counted as Americans.

In two respects the official list has since been supplemented. Firstly, each section has now its special secretary; and the honorary list of the hundred and thirty secretaries will be published in the September edition of the program. Further, most of the sections have an additional array of shorter contributions. As the introduction of the program said from the start, every sectional meeting should offer not only the two official addresses which form a part of the interrelated plan, but also some shorter contributions and communications by well-known specialists on special problems dictated by their own interests without immediate relation to the unity of the program. The official address on the problems of the section forms the natural transition to such special papers exemplifying the work of to-day in the field of the section. The invitations for such shorter contributions have been sent out at the suggestions of the different chairmen, and the chairmen themselves had been chosen at the suggestion of a majority of workers in the special field. But in most sections there is still ample room for any interesting short communication to be offered and any one may enter into negotiations with the chairman of the section to which his paper would belong. In those sections in which the time will not be entirely filled by the short papers discussions will be in order.

An important problem has been the distribution of halls for the meetings. The temporal distribution of the proceedings had already been sketched in the appendix of the program, and it may be said here, by the way, that *everybody can get the program by sending his address to Mr. Howard J. Rogers, Director of Congresses, World's Fair, St. Louis.* This appendix indicated the effort to avoid, as far as possible, every conflict between sections of related interests. Every participant can attend on Tuesday the meetings of three departments and in the following four days the meetings of eight sections, of which each fills a forenoon from ten to one o'clock or an afternoon from three to six. In this way sixteen sections always meet at the same time, but hardly ever sections of the same larger department. On Wednesday, September 21, from ten to one there will be meetings for instance of the following sixteen sections: Metaphysics, history of Greece, history of common law, comparative language, Slavic literature, inorganic chemistry, astrometry, geophysics, meteorology, animal morphology, social structure, public health, otology, civil engineering, public finance and the family. There is hardly a serious conflict of interests. The philosopher, for instance, has on that morning merely his one section on metaphysics while he can attend on the same day in the after-

noon the section philosophy of religion, on Thursday morning the section logic, on Thursday afternoon the section methodology of science, on Friday morning the section ethics, on Friday afternoon the section esthetics, on Saturday morning the section of comparative psychology and on Saturday afternoon the section abnormal psychology. In the same way the chemist, for instance, has Wednesday morning inorganic chemistry, in the afternoon organic chemistry, Thursday morning physical chemistry, in the afternoon physiological chemistry, Friday morning technical chemistry and so on.

It has been thus necessary to secure sixteen halls for the congress, all on the World's Fair grounds. The accommodations of the gigantic fair are amply sufficient for this purpose. We have the festival hall with its seating capacity of four thousand and convention hall with one thousand seats, the congress hall, the hall in the Missouri state building and in the transportation building, each with nearly a thousand seats and a dozen more halls with seats for two to six hundred. The chief aim in the distribution was again to bring together all that is internally related. As far as possible all sections of the same department will meet in the same hall. The lawyers will find all their legal sections in the Missouri building, the medical men will have most of the medical section in the transportation building, the sociologists theirs in recital hall, the pedagogical section will be in the educational building and so on.

There is no doubt this use of all the large halls of the World's Fair will make it comfortable for the audiences even if twenty thousand flock together during the congress week, as of course the large majority would not attend meetings from Monday till Saturday evening without interruption. It may be expected that most guests will attend three or four sections only and will enjoy the fair in the intervals. Twenty thousand ought to be, indeed, the figures of attendance to make use of the seating capacity. Will these twenty thousand really come? If the situation were correctly understood over the land the figure would probably be still larger; five thousand men interested in law or politics or social sciences, five thousand men interested in medicine or natural sciences, five thousand men interested in education, in history or philology or philosophy or mathematics, five thousand men interested in religion, in art, in literature, and there remain still the thousands interested in technology and many other departments. The congress boards hope that these figures are not an excessive calculation.

Only one thing seems to stand in the way of such wide attendance: the unfortunate rumor that the congress does not wish such popular participation. It seems that the misunderstanding arose as though this congress were not intended for the general public, but merely for a narrow set of selected specialists. Nothing can distort more the real intentions. Again and again we receive requests that we send an invitation to that or that friend. The fact is, *every educated man or woman who can appreciate the proceedings, especially every collegiate or professional man, is heartily welcome without any invitation.* The congress does not even demand any fees. While, for instance, the congresses connected with the Paris exhibition asked for considerable admission fees, the International Congress of Arts and Science in St. Louis requires nothing at all but the signing of one's name on the list of participants. The misleading rumor started probably from the fact that the chairmen, secretaries and speakers received special invitations. That, to be sure, was demanded by the whole idea of this congress: that the leading actors had to be selected a long time beforehand as

their work has to form a connected whole, but that does not involve a selection of the public which is to profit from the offerings.

It is true the rumor may have been reenforced by the fact that a limited number of scholars received, indeed, a special invitation to attend in form of a circular, but there was not the slightest intention to indicate that those who did not receive it were less welcome in the audience. To invite all who might have an interest in the proceedings of one of the hundred and thirty sections would have meant to invite half a million persons; every school teacher, every lawyer, every physician, every engineer, every political man, every literary man, yes, every educated business man, would have relations to some of the sections. No committee would have had the right to pick out among that half million those who are especially welcome at the congress, and the fact is no one dared to undertake any such selection. The only thing which the committee believed to be its duty was to send a program and invitation to at least a few thousand from whom special interest could be expected, that is, to the members of the leading national scholarly societies. It is clear that this means not a personal selection; the greatest scholars of the country may by chance not belong to any of these national societies. And thus it has happened, indeed, that some have received such invitations while others of the same high standing did not receive them; a differentiation was not intended at all. The membership lists of some dozen societies were used merely as help in spreading our programs, and it was hoped that every one who received the program would circulate it in his circle and interest his friends in the participation. We should have liked better to send it to half a million, leaving out no student who feels himself interested in any one part of the feast.

Of course the misunderstanding is limited to some quarters; many other symptoms show that the attendance will, indeed, come up to the unusual opportunity. Especially welcome is the movement which seems under way in some western colleges which begin as early as the middle of September. It is planned there to give leave of absence to those instructors who want to attend the congress. The eastern universities, of course, begin late enough to make it possible anyhow for the whole teaching staff to attend the meetings. It is to be hoped that the schools too will adopt a liberal policy and give leave to every teacher who is anxious to go to St. Louis, as this chance to come in close contact with the leading scholars in every field and to take part in this organized effort to bring harmony into the scattered mass of human knowledge is certainly a liberal education for every high aiming teacher. This six-day autumn school promises, indeed, to offer more than all the summer schools of this country and abroad together. Such a combination of speakers was never before brought together—may the combination of listeners and participants show worthy of the unique occasion.

Hugo Münsterberg.
Harvard University.

The Endowment of Astronomical Research.

In order to attain as great an advance in astronomical research during the twentieth century as in the nineteenth, careful plans must be made for its endowment. The same skill in organization, combination of existing appliances, and methodical study of detail, which in recent years has revolutionized many commercial industries, should produce as great an advance in the physical sciences. Astronomy in particular, through the striking progress it has made during the last half century, and its appeal to the imagination, has received

more liberal aid than almost any other science. This has enabled astronomers to develop well-organized observatories, and to carry on large pieces of routine work. They are, therefore, especially fitted for undertaking researches on a scale that will constitute a real advance. It is the object of the present pamphlet to show how this work can be carried still further, how the quality of the work can be raised to a new plane, and how a large or small sum of money may be expended so as to obtain the best results.

There are seven methods by which astronomy can be aided, each of which may be considered in turn.

1. *Fellowships for Astronomical Students.*—A large sum of money would not be required for this purpose. Ten fellowships, each yielding annually $500, would probably be sufficient. They should be used for students especially interested in astronomy, proposing to make it their profession, and showing a capacity for original research. The successful candidates should be sent to universities where special courses in advanced astronomical work are given. It is not desirable that there should be too many such fellowships, since the number of permanent positions for astronomers is limited. This difficulty is partly remedied by No. 7, described below. A large part of the expenses therein contemplated will be for personal services, and as work of the highest grade will be demanded, it is only fair that suitable salaries should be paid. The future of astronomy will depend largely on giving a proper preparation to the men to whom the most important equipments will be intrusted.

2. *Astronomical Expeditions.*—Large sums of money have been wasted in sending out expeditions, in charge of incompetent persons, to observe total eclipses of the sun. If the weather is cloudy at the time of the eclipse no result is obtained; if clear, the newspapers at once announce that a great success has been attained, and results secured which may prove of vast scientific value. In many instances, nothing further is ever heard of such work. The real addition to our knowledge of solar physics during the last thirty years, from such expeditions, considering the money expended upon them, is discouragingly small when compared with what might have been obtained by a more judicious expenditure of the same amount of money at a fixed observatory, where some results of value would surely have been obtained. It is often said that a discovery of so great importance may be made that it would compensate for the entire outlay, but this applies with equal force to almost any other plan of work. The fact that a government or individual will often make the appropriation desired for a special expedition, and would not make it for other astronomical work, in no way lessens the responsibility of those who ask for such aid.

Undoubtedly, every eclipse should be photographed by at least one skilful observer, and especial pains should be taken to solve particular problems, as the existence of an intermercurial planet, sudden changes in the corona, etc. The best method for securing results of real value appears to be that adopted by the English astronomers. A permanent committee is appointed which attempts, year after year, to solve certain problems of great importance. The experience gained during each eclipse aids later expeditions. Government assistance is often obtained in sending warships. Even then, the expenses are likely to be very great, and clouds may cause entire failure. If, therefore, good photographs are obtained, neither time nor money should be spared in making a careful examination and discussion of them.

3. *New Observatories.*—A new observatory of large size should only be established

after careful consideration. The gift of a large telescope, to a university unprepared to receive it, is often worse than useless. Not only can no work of much value be done with it, without a large annual expenditure, but the existence of large telescopes which are idle discourages other donors who see that there is no return for the great outlay. For teaching purposes, a telescope of eight to twelve inches aperture and a three-inch transit instrument are large enough. The best work in observation can never be done except when the atmospheric conditions are excellent, and this would seldom occur near a university or large city. On the other hand, a fruitful field is open in the application of photography to a very large reflector, but the best possible location, preferably in the southern hemisphere, as in South Africa, should be chosen. Such an instrument would be of little value unless means were provided for keeping it at work, and for discussing and publishing the results obtained.

There is one class of astronomical institution, a computing bureau, which might be established to great advantage at a large university, where work of the kind proposed was already in successful operation. At one institution the work undertaken might be the measurement and reduction of photographic plates, and at another the computation of orbits of comets and asteroids. An astronomer particularly successful in photographing the stars might find on his plates the trail of an asteroid of great interest, like Eros. Such an observation would be of no value unless he measured its position and, after taking additional photographs, determined its orbit. This he would do to great disadvantage compared with those who devote their entire time to such work, and could easily procure additional assistants as required.

4. *Publication.*—The cost of publishing many important investigations is too great to be provided for by existing periodicals. Means ought to be supplied so that no really good work should fail to reach the public for this reason. Provision should also be made for lengthy memoirs, the cost of which is sometimes very great, since they include extensive tables or require elaborate illustration. The work of deceased astronomers, when of sufficient value, should also be promptly completed, reduced and published. Probably the Astronomisches Gesellschaft and the Royal Astronomical Society would expend money to great advantage in this way.

5. *Aid to Working Astronomers.*—There is no way in which a more prompt and effective return can be obtained for a moderate outlay than by grants to astronomers qualified to expend them. The replies to the Circular of 1903, described below, and also to the Bruce Circular of 1890, show this very clearly. The number of good applications from German astronomers is particularly large. The sum of $10,000 would permit from ten to twenty valuable researches to be undertaken at once. Many of the ablest astronomers in Europe, and in this country, are obliged to devote nearly all of their strength and energy to teaching. In many cases, their interest is so great that they would gladly give much of their own time to researches of the greatest importance if, by a grant of a few hundred dollars, they could obtain the needed instruments, or employ assistants or computers. A donor could thus obtain, at a trifling expense, the services of some of the most eminent astronomers in the world, in expending his gifts. Care should be taken to make the restrictions as light as possible. A man of genius, in many cases, can not work at all, except in his own way, and at his own time.

6. *Aid to Existing Observatories.*—Several of our large observatories have now

the appliances for a greatly increased amount of work. Large sums of money could be expended for salaries of additional assistants, for publications, buildings, instruments, etc. As the executive organization is already provided, the returns from additional gifts should be very great. Many of the most important advances to be expected in astronomy will be obtained from large pieces of routine investigation. Astronomers having learned the best methods of determining the position, motion, brightness, spectrum and other properties of a star, should be prepared to apply them to great numbers of similar objects. Generally, the person who devises a new method is not the one best qualified to superintend a large corps of assistants, and to carry out an extensive routine investigation which may occupy many years.

7. *International Cooperation.*—This is probably the most important problem of all, and that most likely to lead to a real advance in astronomical science. The best illustration of the work contemplated is the determination, under the direction of the Astronomisches Gesellschaft, of the positions of northern stars of the ninth magnitude and brighter. A committee of experts should hold lengthened meetings and discuss plans in detail. It might be best to publish a provisional plan and invite criticism before beginning work. The observations should then be divided among those best qualified to make them, leaving to each observer greater or less freedom in carrying out the work. Preliminary observations would probably show which was the best method, and it is difficult to see why, in routine work, all should not conform to that. In determining a single quantity, like the solar parallax, of course the greatest variety of methods possible should be used. The reductions, publications and discussion should be made by those best qualified, and not necessarily by the observers.

As an example of the method of procedure, we may suppose a committee appointed who would first consider in turn, and in detail, the present needs of each department of astronomy. The answers to the circular described on page 298, give the views of the leading astronomers of the world, on this question. For instance, in considering the measurement of double stars, they would correspond with all astronomers now engaged in such observations. They would decide whether an undue, or an insufficient, amount of time and energy was directed to this work. They would then attempt to induce observers to adopt the best methods of measurement, and would supply micrometers of the most approved form, when needed. Observers displaying especial skill might be furnished with recorders or assistants who would learn their methods. In discussing orbits of double stars, complaint is often made that certain stars are neglected while a needless number of observations is made of others. If the subject was being neglected, an appropriation might induce a competent observer to take it up. All these difficulties could be reduced or avoided by proper organization, or, when necessary, supervision. The one object would be to secure the greatest scientific return for the given expenditure, and to avoid the reproach of the astronomer of the future, who may say that present opportunities have been neglected.

While a large sum of money, the equivalent of that required to establish an observatory of the first class, would be needed to carry out this plan in full, it will be seen that a moderate amount would permit a portion of it to be tested. The immediate expenditure of $50,000 to $100,000 would show results that would amply justify a larger outlay. Very different ends would

be attained by the different methods. Thus, No. 1 is educational, and insures the efficiency of the astronomer of the future, No. 5 aids the individual man of genius, while No. 6 and especially No. 7 undertake to solve the great problems now before us, and to advance the science to a new and higher plane.

The organization required to carry out this plan must next be considered. It may be divided into two parts, the care of the principal, and the expenditure of the income. The first of these is easily provided for and, if the amount is large, may well be left to the donor. Permanency, a relatively high rate of interest, and certainty that the wishes of the donor will be fulfilled are the three essentials. The expenditure of the income is a more difficult matter. If intrusted to an international committee, frequent meetings can not be held, and correspondence is slow and unsatisfactory in many cases. Such a committee, however, would be able to discuss problems from the broadest standpoint, and would be the best judge, in international work, of what part each country should undertake. A local committee could meet frequently and secure the active interest of several persons, but it could not consist of experts who would have a good technical knowledge of the researches to be undertaken. A national committee would occupy an intermediate position, with some of the advantages, but unfortunately some of the disadvantages, of both. The experience of the writer is that all the work of such a national committee is likely to be left to one man, and even if well attended meetings are held, it often happens that the wishes of the most aggressive member, and not the combined opinions of all, are carried out.

On the whole, the following plan is recommended: The appointment of a local committee consisting of men interested in astronomy but not necessarily familiar with its technical details. Investigators in some department of science, and men of affairs qualified to judge of other men, and of the work done by them, should be selected. With the proper machinery to collect the views of experts, such men could easily carry on successfully the first six of the methods described above. As a parallel case, the board of trustees of a university can select the best man for a professor of Sanskrit, or with expert aid can organize a technical school, although as individuals their knowledge of either subject may be very slight. The duties of this committee would be, first, absolute fairness. They should spend the income so as to secure the greatest scientific return, and should be wholly independent of all personal considerations, and of all local conditions. Secondly, their work should be active, not passive; they should try to spend the income, not to preserve it. Whenever an unusually able memoir was prepared by an astronomer hitherto unknown, they should make a business of learning his needs, what he would require to carry his work still further, and if possible induce him to undertake better or more extensive researches. In many cases, they could excite local interest and could secure aid for him from the friends of his observatory, who might not otherwise know how important it was that his work should be aided. When a grant was made to an astronomer he should be made to feel that, in accepting it, it is he who confers the favor. He aids the committee in securing better results for their expenditures than they could otherwise obtain. Many astronomers are unwilling to ask for aid, owing to modesty, to motives of delicacy; or from fear that the results will not be considered adequate. If the members of the committee are satisfied that the object is a good one, they must take the responsibility of success or failure.

In many cases, they must ask advice of experts; in some cases they must employ them to investigate, or to try preliminary experiments. Often a preliminary appropriation should be made, its continuance or increase depending upon the results attained.

The seventh method described above stands on a wholly different basis from the others. Here the work must be done by experts, the greatest specialists in their departments. Many important investigations have been undertaken by international societies, and such work could be greatly increased if large sums of money were at their disposal for this purpose. As this is, perhaps, the greatest problem in astronomy it might seem presumptuous to discuss it further here.

A brief description of the attitude hitherto maintained by this observatory to other astronomers, is given below, and may explain its present policy in this matter.

One of the objects of the astronomical observatory of Harvard College, as stated in its statutes (*Annals,* Vol. I., p. lix), is 'in general, to promote the progress of knowledge in astronomy and the kindred sciences.' Various examples of the attempts to carry out this plan, by cooperation, publication of work done elsewhere, and in other ways, will be found in the *Annual Reports* and *Annals.*

In 1886 a definite attempt was made to secure the sum of $100,000, the income to be used in aiding other astronomers, and a pamphlet was published describing this plan. Four years later, Miss Catherine W. Bruce gave the sum of $6,000, to show what results could be obtained in a single year. This appropriation was distributed among fifteen astronomers, eight in Europe, one in Asia, one in Africa and five in North America.

The next attempt made by the writer was in 1901. It was thought that a committee representing the principal research funds of the country might render them more effective, and secure harmony in the expenditures of the money now available. Also, that a local committee could do more work than an international or even a national one, since more frequent meetings could be held. Delegates were therefore appointed by the Rumford Committee of the American Academy, and by the trustees of the Elizabeth Thompson Fund. The acting president of the National Academy agreed to attend the meetings unofficially. The members of the committee thus formed, the writer being also included, believed that a larger committee would render the work more effective. Additional members were invited, but no results were obtained.

Other plans were at once prepared, when the establishment of the Carnegie Institution entirely altered the prospects for original investigation in science in the United States, and rendered it probable that the immediate needs would be supplied from this source. No provision, however, has thus been made, so far as the writer is aware, for general aid to astronomers in other countries.

In April, 1903, a pamphlet was published showing how a large sum of money could be usefully expended each year for extending astronomical research. It was stated that much better results could be obtained by cooperation, avoiding duplication of work, providing astronomers with assistants and other means for undertaking neglected investigations, furnishing the means for employing the many large telescopes now idle, and, in general, attempting to improve the present quality and quantity of work done, regardless of individual or country. It was further proposed that the fund should be administered by a committee of astronomers, wholly unselfish and unprejudiced, the only object being to secure the greatest scientific return for the expendi-

ture, and that Harvard should act as trustee of this fund, on the ground of its security, permanency and success as an investor, and since the desire to aid astronomers throughout the world has not been made a part of the policy of observatories elsewhere.

A circular of inquiry was then printed and sent to all the members of the Astronomisches Gesellschaft, of the American Astrophysical Society, to about two hundred members of the Royal Astronomical Society and to a few others. It is believed that few astronomers widely interested in the progress of science, and whose opinion would be of much value, were thus omitted. The replies to this circular were very instructive and valuable, and I take this occasion to thank my friends for the trouble they have taken in the matter.

The following five questions were contained in the circular:

1. How do you think money could be spent most advantageously on astronomy at the present time?

2. Can you recommend any definite plan, in form for presentation to a possible donor?

3. In what way could money be most usefully expended at your observatory, or under your direction?

4. Can you give (not for publication) the names and addresses of any persons who are interested in your observatory, and who are able and might be willing to aid it, if the matter were properly presented to them?

5. What improvements do you suggest in the plan proposed for the endowment of astronomical research?

A discussion of the replies to questions Nos. 1, 2 and 3 would be given here, but it is believed that the writers would prefer a postponement of such action, until the establishment of a fund would enable a part at least of the proposed work to be undertaken.

Question No. 2 should have followed No. 3, as it was intended to refer to either No. 1 or 3. It was hoped that plans would be sent which could be enclosed in the letters proposed below, in discussing No. 4. If a large sum of money were already available, many definite plans would doubtless have been presented. The answers to No. 2 were in some cases covered by No. 1 or No. 3.

But few answers were given to question No. 4. I had hoped that an influential advisory committee could render important aid through this question. If the members were satisfied that an astronomer was doing excellent work and needed money for an important investigation, they could call the attention of the friends of his observatory to the matter very effectively. In many cases an astronomer would hesitate to do this himself, and the opinion of unprejudiced experts ought to have a weight that would not attach to the views of the individual concerned. I should be very much gratified if astronomers considered the work of the Harvard Observatory so important that they would take such action regarding the additional work I wish to undertake.

An excellent suggestion in reply to question No. 5 was made by Mr. A. R. Hinks, of the Cambridge Observatory, England. He recommended the publication of proposed forms of investigation, in order to secure the criticism of astronomers before, instead of after, it is too late to alter them. This seems to be especially important in the case of large pieces of routine work.

Few improvements or criticisms of the plan were suggested by foreign astronomers. One or two advised that the committee should be international, but probably the general feeling was that, as it was hoped to collect the funds in the United States, it

was only fair that they should be controlled by Americans.

Among American astronomers, however, strong objections were made to the part it was proposed that Harvard should take in the plan. For this reason two leading astronomers declined to serve even on an informal advisory committee. It was explained that this objection did not arise from jealousy of Harvard, or from fear that the plan would not be well carried out there, but from a belief that one observatory should not be more prominent than another in such a scheme, and that the control of such a fund and of its expenditure should be wholly independent of any one institution. I believe that the selection of a trustee for the care of the proposed fund should be made by the donor, and had expected that the informal advisory committee would have recommended some method of appointing the final committee, which would have secured unprejudiced action. The function of the first of these committees would have been to propose a plan like that described above. This want has been supplied, in a great measure, by my friends, Mrs. Henry Draper, Major E. H. Hills, Professor Simon Newcomb and Professor H. H. Turner, to whom I am indebted for important suggestions in preparing this pamphlet.

There are certain advantages to be gained by throwing the responsibility upon a single individual or institution, as all mistakes or failures can then be located and remedied. Continued efforts will accordingly be made by the writer to accomplish the desired results. As other observatories have not expressed a wish to aid astronomers elsewhere, there seems to be no objection to making it a part of the policy at Harvard.

The present discussion has been published to supplement that issued in 1903, a copy of which will be sent to those who desire it. It is believed that present conditions are unusually favorable for securing great progress in astronomical science. It is hoped that a sum of at least $50,000 may be obtained for immediate expenditure, so that a beginning may be made at once, and astronomers may have an opportunity to show what results they might obtain with unrestricted means.

My one object is to secure a real advance in astronomy. Any plan that will attain this will have my hearty support, if desired. If this advance is made, it is a matter of little importance whether the part taken by the Harvard Observatory, or by myself, is large or small.

EDWARD C. PICKERING.

July 11, 1904.

THE CHANGING ATTITUDE OF AMERICAN UNIVERSITIES TOWARD PSYCHOLOGY.

IN this adolescent period of its growth, psychology may be pardoned for wondering if its elder brothers understand the manhood it is attaining. The distortion by the public prints, in their eagerness to be a little more than up-to-date, has thrown numerous fads of 'mental science' out of all perspective, and resulted undoubtedly in the injury of psychology. At the present time, however, the general reader is learning to discriminate 'yellowness' in what purports to be psychological news. When the Sunday special announced in January of this year that the soul of a rat had been observed in the laboratory of a Washington psychologist, few had difficulty in pigeon-holing the article with another which declared, about the same time, that a California physicist expected to turn negroes into white men by the use of radium. In the following pages the writer collects certain facts which bear upon the recent development of psychology in American institutions of higher learning, with the hope of giving more adequate means for judging the present status of this sci-

ence. The data are taken from the catalogues of 150 colleges and detailed information furnished by the directors of 34 prominent laboratories.

Ten years ago, Binet stated in the opening chapter of his 'Psychologie Expérimentale' that there were 14 laboratories in Europe and 16 in America. To-day there are at least 54 universities in the United States and Canada having psychological laboratories. The equipments of 25 of the largest average in value over $4,000, while in 1893 it was estimated* that the total psychological equipment in the United States was worth approximately $30,000. This material prosperity, small as it is, becomes noteworthy when it is considered that 1904 marks only the twenty-first anniversary of the establishment of the first American laboratory.† Experimental psychology in this country is just becoming of age.

A more important advance than this acquisition of apparatus is the change in the character of instruction in the institutions of higher learning. Some introduction to descriptive psychology, under the title of mental philosophy, was part of the established order even in the early American colleges. At first it fell often within the province of the president to teach psychology and philosophy. Among the institutions which to-day have 15 or more in their faculties, the presidents of only nine preserve their colonial function of occupying the chair of philosophy. Moreover, there are only five among the 150 institutions‡ studied in this paper, in which no instruction in psychology is given. These five are Catholic schools.

Psychology is now organized as an entirely separate department in four universities, and there are professors or assistant professors having the title in psychology in about 30 others. The administrative arrangements in these latter are such as to associate psychology in the same department with either philosophy or education. In the middle west, especially, we find a movement to connect psychology and pedagogy. This is true of Colorado University, Cornell College, Upper Iowa University, South Dakota University, Illinois University, Ohio State University and the New York University School of Pedagogy. In all the other colleges psychology preserves its old affiliation with philosophy. On account of its intimate relation, as a pure science, to the philosophical disciplines, the close connection of these two departments may be expected to long continue. Many of the professors in both subjects regard it to their mutual advantage to preserve this condition. If we ought not to expect the growing strength of psychology to be manifested in the establishment of independent departments, we may yet find it shown in the size of the instructional force. There are to-day 45 colleges employing more than one person to give courses in psychology. The largest faculty in psychology is found at Columbia, where eight men give their entire time to the subject and four others give part time. Seven universities employ five or more for instruction in psychology.

The department organization, as above outlined, shows less progress than the rapid differentiation of the subject matter taught. Subdivisions have increased in number and strength, until recently a specialist in the application of psychology to teaching was made 'professor of educational psychology.'

* 'Report of the United States Commissioner of Education,' II., 1139.

† Founded at Johns Hopkins by G. Stanley Hall.

‡ The colleges were selected on the basis of the size of their faculties, as shown by the Report of the U. S. Commissioner of Education for 1901. All institutions of college rank having 15 or more in their faculties were taken; 95 of them had faculties of 20 or more members.

Comparative psychology, which considers the mental life of lower animals, no longer retains its place on the skirmish line; separate instructors, rooms and equipment mark its permanent position in the university. Twenty-two colleges now offer curriculums with comparative psychology cited as an independent course. In planning for the new laboratory in Emerson Hall, Harvard, a comparative psychologist went to Europe expressly to study the German 'institutes,' so as to be ready to introduce the most perfect arrangements for studying the psychology of animals. Besides these subtopics there are a score or more of others treated in separate courses by officers of the psychological departments. Intimately related subjects, like anthropology and sociology, have become university departments. The instructors in psychology, in addition to the familiar courses in descriptive and experimental psychology, are teaching such phases of the science as physiological psychology and abnormal psychology; genetic psychology and child study; historical, analytical and systematic psychology; the psychology of the emotions and will, the psychology of logic, of esthetics, of ethics and of religion; the application of statistical methods to psychology; experimental phonetics and various other investigations in special fields. There are at least 62 colleges where three or more courses with psychological titles are announced in the catalogues; 38 give five or more courses. At Columbia the department of psychology alone offers 20 different courses. The present differentiation in psychology is more noticeable when compared with the condition ten years ago. Professor Delabarre, writing at that time for *L'Année*, outlined the courses in the 26 American institutions. Only 16 then offered as many as five courses.

Turning from the attitude of the faculties toward psychology to the opinion among the students, the data which have been furnished by the laboratory directors are suggestive.* The student view is certainly of vital importance; psychology must depend largely on it for the future. The records at hand approximate the registration in psychological courses among 34 universities, each of which has a laboratory equipment worth $1,000 or more.† In trying to estimate the importance of psychology in the work of the student body, the registration in this department may be compared with the total enrolment of the colleges in which psychology is offered. These are only the graduate school and the colleges of pure science, of literature and of arts. The class rolls in psychology for the group of universities studied include this year from 10 to 50 per cent. of the students to whom it is offered.‡ Clark University, where the enrolment in psychology reaches about three fourths of the students, ought to be considered apart. Its position in regard to graduate study in psychology is unique on account of the prominence of President G. Stanley Hall, which has attracted a group of students with psychological interests. By omitting Clark our average becomes quite representative of conditions in the larger institutions; we find that the attendance on psychological courses is approximately 20 per cent. of the total enrolment. It seems fair to suppose that a third of the students in these 34 institutions, even in the colleges of science, literature and arts, can not

* I wish to take this opportunity to thank some fifty professors who have shown much consideration in supplying information regarding attendance on courses, laboratory equipment, etc.

† For a list of the institutions considered, see the discussion of laboratories, later in this paper.

‡ It has not seemed advisable to try to exclude double registrations in psychology, as they are comparatively few, and as in some cases only the approximate enrolment has been furnished.

register for psychology. Freshmen are excluded in all but eight, while eight do not admit even sophomores. The average enrolment in psychology would, therefore, mean that about 30 per cent. of the students to whom it is offered are taking some course in this department. With the shifting registration during the last three years in college, when the subject is generally taught, it is hardly claiming too much to suppose that 60 per cent. of the graduates from the larger universities in America today have taken at least an introductory course in psychology. When it is remembered that psychology is required for graduation in only eight of these larger institutions, the popularity of the subject among students can hardly be questioned.

Any ranking of the universities as to attendance in psychology would have little meaning on account of the numerous local factors which affect the enrolments. In some institutions an introductory course is required of all juniors; again we find that the percentage is reduced by the student interest scattering among the many prominent professors in large universities. The percentage of students studying psychology in Harvard, Yale and Chicago, for example, is in each case slightly below the average, while the number of students to whom they offer psychology is larger than anywhere else except Columbia. At the last-named institution the percentage reaches 32, but the students are required to take an introductory course, which is left optional in the other three. Cornell occupies a medium position; its enrolment in psychology is just 20 per cent. By comparison with reports from the other laboratories, the distribution of students among the various courses given at Cornell seems to be quite typical. In detail it is as follows: Number of students in the colleges where psychology is offered, 1,200; attending the introductory courses in psychology (open to sophomores), 175; the experimental course (open to juniors), 30 students for one semester, 20 continuing for the year; the research courses, 6 graduates doing major work and 6 undergraduates taking up minor problems; the psychological seminar, 15 students, limited.

Some idea of the actual number studying psychology may be gained from the fact that the introductory classes at Columbia, including Teachers College and Barnard, show an enrolment of 435 students; at Harvard, 300; Princeton, 250; Nebraska, 225; Cornell, Minnesota, Toronto and Wellesley, 175. The interest manifested by graduate students in productive work is best illustrated by a quotation from the address of Professor Cattell, as chairman of the section of anthropology of the American Association for the Advancement of Science: "In the year 1897 there were given by American universities eighteen doctorates with psychology as the major subject —more than any science except chemistry, six times as many as in astronomy, and nine times as many as in anthropology."* A summary published in 1903 showed that in five years the number of doctorates in psychology had been 68. Only three other sciences were credited with more—chemistry, 137; zoology, 72; and physics, 69.† Each of these doctorates meant the completion of an original investigation in the field of the major subject.

In winning its way to favor among scientific men, psychology has depended largely on its experimental work. The improvement in quality can only be apprehended by comparing the recent volumes of the technical journals in psychology with those of ten years ago. The adoption of new statistical methods, the use of correlation in studying psychological problems, the

* Science, VIII., 533.

† Science, April 10, 1903.

revolution in educational psychology which is placing its research on a very different basis than enumeration of answers to questionaires; these and other changes have introduced quantitative work in a way that was regarded as almost impossible a decade ago. That the students are acceding to this demand for training in refined methods of measurement is partly attested by an average enrolment of 25 students in laboratory courses in 34 institutions where the best facilities for this work are offered. In 19 of these universities we find seminars devoted distinctly to psychological problems. Still more encouraging is the fact that more than a hundred graduate students are to-day carrying on research in residence at these laboratories, while 63 undergraduates are investigating minor problems. Few other sciences can show an equal record, and certainly no other country approaches the United States in the number occupied in zealous psychological research.

It is ten years since any comprehensive survey of American facilities for psychology has been published. At that time Professor Delabarre described each of the laboratories in the United States, 26 in all.* A separate account of each laboratory is to-day out of the question. We must content ourselves with tabular statements. A study of the larger laboratories shows that they fall conveniently into three classes on the basis of the value of their equipment. This grouping, it must be remembered, is for convenience and is not intended to indicate the relative importance of the laboratories. The first group embraces those which have apparatus and fixtures valued at $\$10,000 \pm \$2,000$. This includes: Clark, Columbia, Cornell, Harvard, Pennsylvania and Yale. A second group contains those the equipment of which ranges in value between $\$5,000 \pm \$2,000$. In it are Brown, Chicago, Indiana, Iowa, Michigan, Princeton, Toronto and Wisconsin. The third group embraces all the other laboratories here studied. The equipments are valued between \$1,000 and \$2,000. It includes Bryn Mawr, California, Cincinnati, Colorado, Illinois, Indiana, Kansas, Leland Stanford, Jr., Minnesota, Missouri, Mount Holyoke, New York University School of Pedagogy, Northwestern, Ohio State, Randolph-Macon Woman's College, Texas, Vassar, Wellesley and Wesleyan. Under this arrangement the average equipments of the universities in each group are approximately \$10,000, \$5,000 and \$1,500, respectively.

The income of the laboratories might better express their potential value. Annual appropriations for improvement range from \$100 in a few of the smallest to \$1,000 in five of the largest; the average is slightly over \$400. These sums are small considering the needs, but, nevertheless, represent a condition which means the doubling of the equipment about every ten years, even if the generosity of the university authorities is not further awakened. In spite of the constant increase in equipment, the directors of the best laboratories are seriously embarrassed in trying to meet the demands made upon them for instruction in experimental work. The opening of tempting fields of investigation has to be postponed until the needs of the present courses are met.

Another mark of the material development of this youthful science, and particularly of the large research interest in the subject, is found in the increasing space occupied by the department in the university buildings. In the following institutions ten or more rooms are now devoted exclusively to psychology: California, Chicago, Clark, Columbia, Cornell, Harvard,

* *L'Année*, I., 209–55.

Indiana, Iowa, Leland Stanford, Jr., Michigan, Pennsylvania and Toronto. Yale should be grouped with these on account of its plan to retain a very large room for undergraduate experimental work, instead of dividing it up as is done elsewhere. On an average, eight rooms are occupied by psychology in the group of universities considered. The further scientific progress of psychology is assured by a general plan to provide as many separate rooms as possible to be used for research work. Six out of the eight rooms are usually available for special investigations. On account of the necessary isolation of the experimenter in psychology, this provision is of vital importance to the science.

The demand made upon the laboratories for research equipment is reflected also in the establishment of complete workshops in connection with the department. The psychological workshop has reached its most prominent development at Yale and Columbia. At New Haven the equipment of the shop is valued at $2,000. A teacher of manual training spends half his time during the school year and all of his time during the summer working for the department. A student also frequently assists in the shop. At Columbia a skilled instrument builder and a boy assistant are employed the year around; the value of the shop equipment is approximately $1,000. Cornell is soon to add a new workshop to its splendid laboratory equipment. It has for some time employed a mechanician half the day. Several of the laboratory directors prefer to have large pieces of apparatus built outside the department, and, therefore, maintain only a small shop for repairs. Of the 34 universities, all but seven have made provision for at least a work-bench and tools in the department.

To judge the worth of a laboratory on the basis of floor space and dollars invested is certainly unwise; yet size and capital are not unimportant considerations, even when comparing institutions of learning. An interesting classification of a different nature is suggested by the 'Statistics on American Psychologists,' recently published.* The ranking indicates something of the past performance of the older laboratories. The article considers 200 psychologists and tabulates the institutions that have contributed to their academic training (undergraduate and graduate). The seven highest rank as follows: Columbia, 42; Harvard, 42; Cornell, 27; Yale, 23; Princeton, 20; Pennsylvania, 17; Johns Hopkins, 13; 66 other institutions have also taken part in stimulating some of these prominent psychologists. It is recognized, of course, that this ranking overestimates the time that the laboratory has been in service. In proportion to the number of students working in certain younger laboratories, it may be said that the contributions to the science which they are making is often fully equal to the splendid achievements of those longer established.

In one respect the American laboratories differ distinctly from the German. The latter are often impressed by the personal interest of their directors, which shows itself in some special line of investigation. The laboratory of Stumpf at Berlin, with its complete technical equipment for auditory work, is a striking example. It may be said, however, that certain tendencies do seem to characterize a few of the older laboratories in this country; although in no case do they interfere with a broad teaching of all phases of psychology. In this science, as in all others, the American university first of all teaches, and teaches well. Nevertheless, the trends of thought which prevail among graduate students at present suggest that those who are funda-

* J. McK. Cattell, *Amer. J. of Psychol.*, XIV., 324.

mentally interested in philosophy gravitate to Harvard; those seeking primarily the scientific attitude find Columbia congenial; Cornell is the best university to place the student in touch with the historical development of experimental work and of systematic psychology; Clark is most widely known for its pedagogical interest in the science; Princeton for the biological interpretations of Professor J. Mark Baldwin; Yale for training courses in psychological measurement; and Pennsylvania for the introduction of extended experimental work into its sophomore introductory course in psychology. Nearly all the larger laboratories have some feature in which they are better prepared for specialization than their contemporaries. Only an extended study of the products of each would reveal these fruits of successful development along particular lines.

Satisfactory as have been the gains in the past, there are signs which point to fully as large growth for psychology in the near future. That the reader may sense more vividly the increasing stature of the science, there are given below the condensed statements of laboratory directors as to definite improvements now contemplated or just completed:

Harvard.—New quarters for the psychological department are to be provided in Emerson Hall, the $200,000 building which is now being constructed for the exclusive use of philosophy and psychology. The laboratory will occupy the third story, 22 rooms. Sixteen rooms will be available for research. Library, seminar and lecture rooms will be located on the other floors.*

Johns Hopkins.—No detailed plans made as yet, but a fully equipped psychological department and laboratory will be established by Professor J. Mark Baldwin, who previously founded laboratories at Toronto and Princeton, and has recently been called to this university. Professor George M. Stratton, of California University, has also been secured by Johns Hopkins for the work in psychology.

Leland Stanford, Jr.—The department has moved this year into new quarters, which Professor F. Angell expects to have fully equipped with apparatus in about eighteen months. The new arrangement provides a lecture room for a hundred students, a library and seminar room, two office rooms (one of which may be used for research), a work room, two dark rooms, a silent and dark room, five large closets for storage, drum smoking, lockers, etc., and nine other rooms for investigation and instruction.

Michigan.—A one-story building, 125 x 35 feet, this year was assigned to the psychological department. It provides 15 rooms, including two dark rooms, all provided with water, gas, low and high potential electric currents.

Cornell.—The building of the new Goldwin Smith Hall will provide a demonstrational laboratory, equipped by a special appropriation, and also a large lecture room fitted up for psychology. Besides this addition, the present quarters in Morrill Hall will be increased by adding at least two rooms and possibly as many as eight. A new workshop with improved equipment has been provided this year. It is the plan at Cornell to buy three or four big pieces of apparatus annually, pieces like the Wundt tachistoscope, the Helmholtz vowel apparatus, etc. New apparatus for quantitative drill work and for class demonstration has been built recently.*

Pennsylvania.—In 1903 a lecture room with a seating capacity of 50 was equipped with laboratory tables and with lockers for

* Hugo Münsterberg, *Harvard Graduates' Magazine*, IX., 424–433.

* E. B. Titchener, *Amer. J. of Psychol.*, XIV., 175–191; XV., 57–61.

each student. Another large room was divided into seven small rooms, principally for use in research. These rooms are all wired for telephones and electric currents. The two improvements cost $2,000 and Professor Witmer expects to spend from $1,000 to $2,500 in the near future in further fitting these rooms for original investigation. He will then have a time room, rooms for chronoscope and chronograph, a subject reaction room, small and large dark rooms (the latter 50 feet long for visual experiments). Special provision is to be made for readily making psychological tests on normal and defective children. Within the next two years the department expects to secure two additional rooms.

Clark.—The organization of philosophical and psychological departments in the college has taken place this year; Professor C. E. Sanford gives the courses in philosophy and James P. Porter those in psychology. An appropriation of $1,500 was made for fitting up this new department in addition to the graduate laboratory in charge of Professor Sanford.

Nebraska.—The department is to have seven rooms, 2,400 feet of floor space, on the upper floor of the new physics building, now being constructed. At present it has four rooms.

Wesleyan.—A suite of four rooms became available for the department this spring; only one room was used previously.

Vassar.—A thousand dollars was appropriated in 1903 to establish a psychological laboratory under the direction of Dr. Margaret F. Washburn.

Bryn Mawr.—The department will move next year into a building now being constructed and will occupy five rooms, instead of four as at present. An assistant in the laboratory was added last year.

Yale.—Dr. C. M. McAllister was this year appointed instructor and W. M. Steele made assistant in the laboratory. Apparatus necessary for the experimental course is being duplicated so as to provide a complete equipment for each group of two students.

Texas.—Psychology in charge of Dr. Warner Fite is this year given apart from the school of pedagogy.

Wisconsin.—Professor Jastrow contemplates adding rooms equipped for comparative psychology and the employment, together with other departments, of a mechanician. A shadowless room for stereoscopic research has been constructed this year.

California.—An instructor in experimental psychology, Dr. P. S. Wrinch, was added this year to the instructional force.

Chicago.—Professor James R. Angell expects a new building for psychology eventually, although not immediately.

Minnesota.—New quarters are expected if a building is constructed for history, political science and philosophy.

The recent record of psychology makes it plain that a statement of Professor Titchener, of Cornell, made in 1898, has now become trite. Speaking of psychology in an article in *Mind*, he said: "The training that can now be obtained in the American laboratories is at least as good a fitting for work in an American university as can be gained in Germany."* America has excelled Europe in psychological equipment for ten years. That the progress has not stopped with gaining an advantage in value of equipment is a matter of congratulation. In promoting this younger science, the young nation has not hesitated to continue to enlarge the opportunities for psychology, trusting to the workers in the science to refine the quality of the output.

The foregoing paper has aimed to bring

* 'A Psychological Laboratory,' *Mind*, N. S., VII., 330.

together various views of psychology that may be gained from a university standpoint: The enlargement of the portion of university appropriation devoted to this science; the broadening interest and increasing specialization within the department of psychology itself; the advanced position attained in the university faculties; and the growing favor among students and among scientific investigators. In the history of this institutional development the psychologists themselves deserve much credit. They have continually justified the confidence placed in them by intensifying their instruction and by increasing the merit of their literary and research contributions, until to-day these rank with the best of any nation.

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SCIENTIFIC BOOKS.

Gems and Gem Minerals. By Dr. OLIVER CUMMINGS FARRINGTON, Curator of Geology, Field Columbian Museum, Chicago, Ill. Chicago, A. W. Mumford. 1903. Imperial 8vo. Pp. xii + 229, with plates in color and black and white.

This work is a popular and comprehensive book on the subject of precious stones, treating of their finding, cutting, history and chemical composition. It is intended to supply a long-felt want for an inexpensive popular treatise adapted alike to the mineralogist, the jeweler and the general reader; and the work is one full both of illustrations and information. The nature of the leading gems, their occurrence, their mining, their color, luster, hardness and specific gravity; their optical properties, their crystalline form, their cutting, and the various superstitions connected with them, are treated in successive chapters in the order named. The minor gems follow in their natural sequence, a chapter or part of a page being devoted to each of the principal species and varieties. The volume is printed on good paper, and in large clear type. The illustrations are of two kinds, in colors and in black and white, the latter giving maps of gem regions, methods of mining and the various forms of natural and cut stones, most of the maps being made by half-tone processes and many of them very exact. The special feature of the work, however, is found in the numerous plates produced by the three-color process, and in most cases direct from the objects themselves. The application of this method makes possible a vivid presentation of most of the varieties of precious and semiprecious stones, almost exactly true to nature, a result which of course could not be attained by any black-and-white process.

Some of the plates prepared for this book have already appeared in that excellent and instructive popular publication, 'Birds in Nature,' issued by the same publisher, whose reprints of birds and other natural objects have been adopted by many educational institutions for use in teaching, in so much that more than 100,000 plates have been ordered by a single school committee. Others of the plates are reproduced from the great work, 'Edelsteinkunde,' by Dr. Max Bauer, who was one of the first to utilize the three-color method with success.

Dr. Farrington has had peculiar advantages in preparing such a work, from his position in charge of a great reference collection. This is based on the Tiffany collection of gems gathered for the Columbian Exposition at Chicago in 1893, and subsequently purchased for the Field Columbian Museum, where it is now installed in Higinbotham Hall. It is the best book published up to the present time as regards text, illustration and exact facts for a low price and useful to every mineralogist or collector of gems.

The color work in the gem plates compares remarkably well with the three-color work of Ives, who has attained excellent results, more particularly, however, with porcelains, enamels, pottery, etc., and is somewhat in the line of the plate illustrating North American gems issued by the U. S. Department of Mining Statistics in its report for 1899.

The Heliotype Company, of Boston, Mass., also, have printed (unpublished) a most re-

markable color reproduction of a slab of Mexican onyx, which for realism and beauty is as yet unrivaled.

It is not, of course, within the province of an inexpensive work like this to furnish such splendid plates as those illustrating the Heber R. Bishop book on jade—notably the lithographic work of the art objects by Prang, and of the archeological objects by Forbes, of Boston; or the etchings of the French artists, which were colored by being rubbed in with the hand, on the etched plates, that is, the color and the tintings were applied to an etching plate, giving both an artistic as well as a realistic and charming effect; or some of the Chinese wood-cuts, made by the artists in their own homes, from native specimens, and printed on the thinnest paper, which was then mounted. Dr. Farrington's volume contains thirteen plates, while Bauer's great book has twenty in color; but 'Gems and Gem Minerals' contains about one sixth the text of Bauer's book, and sells at one fifth the price.

To digress for a moment from the review, a few words upon color illustration may not be amiss. Illustrations for works upon science and art have become possible, both in kind and in cost, within recent years, by the wonderful advances in photographic reproduction, to a degree that is indeed remarkable. Plates that are almost perfectly true to nature can now be furnished in black and white at one tenth the cost of producing them twenty years ago; and color illustrations are now within the reach of students of entomology, ornithology, and, indeed, almost all branches of zoology and botany, to an extent formerly impossible. The realistic effect of such illustrations is often admirable; and these processes can be used in a multitude of cases where either lithographic or hand-colored work would be out of the question on account of its far greater cost. These expensive processes remain for luxurious and elaborate works, in which cost is not considered; but the half-tone and three-color methods have an immense and most valuable field in educational and popular uses. The question whether a book is to be a commercial success, when sold at from two to ten dollars a copy, or is to be privately printed in a limited edition, for distribution as a gift by a wealthy man or a large institution, regardless of cost, for the purpose of describing a great collection, naturally involves an immense difference in the character of the make-up.

Among the first successful attempts to apply colored illustration to this department of natural objects, were the plates in the volumes by Sowerby, on British and exotic minerals, published in the early part of the last century. In other branches, especially in ornithology, entomology and botany, hundreds of volumes have been illustrated in color, often with great accuracy and beauty, in a manner rarely employed in mineralogy or geology. This difference may be due in some degree to the fact that birds, insects and flowers have greater interest than minerals for the general public; but it is also largely caused by the difficulty of reproducing successfully the peculiarities of crystalline form, especially when grouped, and the varying effects resulting from differences in luster and transparency. Among the first to avail themselves of the new processes, in a popular point of view, were Messrs. Funk & Wagnalls in the gem and other colored plates in their Standard Dictionary. The bird and similar color illustrations of Mr. Mumford have already been noted, and their extensive adoption in schools, etc., thoughout the country. One of the latest and best examples of fine color work is in the monumental treatise on Indian baskets, by Dr. Otis T. Mason, recently published by the Smithsonian Institution. All these, however, notwithstanding their beauty and fidelity, and their great general value, can not be compared with such splendid illustrations as those of the North Carolina Geological Survey, which is now publishing a volume upon 'Gems and Precious Stones,' to contain four colored plates, by Taber Prang Art Company, or the Bishop jade catalogue, already referred to, or the great forthcoming work describing the Morgan collection of porcelains, which will consist of an edition limited to 250 copies, and will be of regal elegance in every way;

or the new description of the Morgan gems, which is to present the finest combination of realistic accuracy and artistic beauty yet attained. GEORGE F. KUNZ.

Laboratory Exercises in Physical Chemistry. By FREDERICK H. GETMAN, Ph.D. New York, John Wiley & Sons. 1904. Pp. 241.

Laboratory manuals in physics and in chemistry separately have been put upon the market during the last twenty years in sufficient number to satisfy all reasonable demands on the part of the general public. But during this interval a field that overlaps both of these has become differentiated, the start being made by Ostwald, whose work has been taken up and enlarged by a considerable number of ardent workers. Many of the laboratory operations involved are not provided for in the current manuals in English. Ostwald's 'Physiko-Chemische Messungen' and Traube's 'Physikalish-Chemische Methode' cover the ground well in German, but, as is so often the case in German books, the amount of detail involved in the effort to be exhaustive, and the large number of references to researches not easily found in most American college libraries, deprive them of much of their value for American beginners.

Dr. Getman's admirable little book has been prepared with constant recognition of the American demand for directness and economy. His own experience during the last few years in Johns Hopkins University, where physical chemistry was the subject in which his doctor's thesis was prepared, has been linked on to several years of previous experience in the teaching of chemistry. His effort has been to select only such methods for presentation as he has found to be typical and worthy of preference. He has very decidedly the teacher's instinct, exhibiting much aptitude in the art of arrangement and of clear expression. Although the book is not yet two months out of press, it has been already adopted in a number of university laboratories. It certainly meets well the needs of the beginner in physical chemistry and is worthy of special commendation as a handbook.

The range covered may be briefly indicated. In the introductory chapters the author discusses the theory and use of the balance; volume and density; viscosity and surface tension; and the determination of solubility. Thermometry and calorimetry are then considered, and a chapter on optical measurements is introduced. This is followed by several chapters on electrical measurement of conductivity, electromotive force, current and the dielectric constant. The last chapter is on chemical kinetics as illustrated in reactions of the first order, like the inversion of cane sugar, and of the second order, like certain cases of saponification.

The book closes with a well-selected series of tables and an index.

W. LE CONTE STEVENS.

DISCUSSION AND CORRESPONDENCE.

THE USE OF ROMAN NUMERALS.

ROMAN numerals are frequently used to designate the volume of a serial in bibliographic references. Instead of writing Vol. 88, or merely 88 after the name of the serial, we go to the trouble to write LXXXVIII. Why? Simply because we have seen others do it, and have unreflectively imitated them. When we are forced to defend our usage we find that there are few reasons for the use of the Roman system, whereas there are many reasons for the use of the Arabic system. Those who are intelligently in favor of the Roman numerals in bibliographic work argue that the use of them enables us to avoid the abbreviation for volume, while at the same time we thus distinguish sharply between volume and part, or volume and page. They, furthermore, urge that it is well for us to conform to the usage of publishers. But these arguments should be considered in the light of the following facts.

Although no one would deny that it takes much longer to write and read the Roman numerals than the Arabic, and that we are far more likely to make mistakes in dealing with the former system, few of us realize how great the difference in the ease and accuracy with which we use the two systems really is. In order that my arguments for the use of Arabic instead of Roman numerals, not alone

in bibliographic work, but also in all cases where there is no clear advantage in favor of the more cumbersome system, might have the support of quantitative data I have chosen ten well-educated, and in most cases scientifically trained individuals, and determined for each the time necessary for the writing of the Roman and the Arabic numerals from 1 to 100 and the number of errors made, also the time necessary for the reading of the Roman and the Arabic numerals from 1 to 100 when they were irregularly arranged so that the reader did not know what order to expect. In all cases the number of errors made unconsciously was recorded. These measurements furnish the following startling averages: *It takes three and one third times as long to write the Roman numerals from 1 to 100 as the Arabic, and the chance of error is twenty-one times as great; it takes three times as long to read the Roman numerals from 1 to 100 as the Arabic, and the chance of error is eight times as great.*

In case of a quick and accurate mathematician, whose familiarity with the Roman system surpassed that of most of the individuals tested, the results were: time for writing Arabics, 107″, errors, 0; time for writing Romans, 357″, errors, 5; time for reading Arabics, 62″, errors, 2; time for reading Romans, 131″, errors, 5. For one well-trained scientist, who has cause to use the Roman system almost every day, the number of errors in the rapid reading of the Romans was 15!

These figures certainly indicate the desirability of using the Arabic system wherever there is no urgent need for the simultaneous use of two or more systems of numerals. Even if there were no saving of time and strain by the avoidance of the cumbersome Roman symbols, the far greater accuracy gained by the use of the Arabic system should at once settle the matter for all scientists.

Robert M. Yerkes.

Harvard University.

[The best usage in bibliographic work is to use heavy-faced Arabic type for the volume number. The number should be underlined in the manuscript with a waving line, and it will then be set in heavy-faced or block type by the printers. This usage we think originated in American botanical publications. The volume number in heavy-faced type is followed by a colon and then the page numbers are given in ordinary type. The date or year then follows after a period, though we should suppose that a comma would be better. The International Catalogue of Scientific Literature has adopted the heavy-faced type for the volume number; this is followed by a comma and the year, the page numbers being then given in parentheses after another comma. We think that the American usage is the better and should be pleased if our contributors would follow it. The pages of the International Catalogue are disfigured by hundreds of thousands of needless parentheses and periods.—Ed.]

SPECIAL ARTICLES.

PUPATION OF THE KELEP ANT.

The larvæ of ants share with those of butterflies and moths the habit of spinning cocoons in which their transformation to the adult form takes place, though not all the ants make cocoons. Lubbock states that 'as a general rule, the species which have not a sting spin a cocoon, while those which have are naked,' the implication being, apparently, that less protection is required by species having stings with which to defend themselves. It would seem, however, that the absence of the cocoon rather than its presence is to be looked upon as the adaptive character. The keeping of the insects from drying out during the inactive period of transformation is probably a more important general function of cocoons than that of protection against enemies, but the moist underground chambers and compact social organization of the ants have rendered cocoons unnecessary, and in many genera they have been dispensed with.

The family Poneridæ to which the kelep*

* The kelep has been identified by Dr. Ashmead and Mr. Pergande as *Ectatomma tuberculatum* Oliv., a species widely distributed in tropical America, including Mexico, and hence the more likely to become established in Texas. It does not follow, however, that the instinct of attacking the boll-weevil is possessed in an equal degree by

belongs is a primitive group, and breaks Lubbock's rule by retaining both stings and cocoons. Its method of pupation is, therefore, of special interest, and has been recently observed at Victoria, Texas, by Mr. G. P. Goll, whose summarized report reads as follows:

August 1. 5 P.M. Another larva is ready to pupate and two keleps are industriously attending it. One seems to be cleaning the larva, while the other is depositing earth around its head.

7:30 P.M. Six ants are now covering two larvæ with earth, while the latter are continually squirming about and disturbing the earth thus piled over them.

10 P.M. One larva is completely covered and the other almost so.

11:25 P.M. Two ants are removing the earth from the first larva covered, showing that it has spun a cocoon. The other larva is completely covered, and third is being worked upon.

11:35 P.M. The first cocoon has been taken to another chamber and the particles of earth are being removed.

10:10 next morning. The third larva which was being covered at 11:30 last night has finished its cocoon, and has been carried away. This is the fourth larva that has pupated since 4 P.M. yesterday, in eighteen hours.

From these and other observations the following facts and inferences have been reached:

The larva is entirely covered with earth when ready to pupate.

This earth is necessary as a basis for the cocoon.

The squirming and apparent objection on the part of the larva is an instinctive action to keep the earth from being packed too close around it, and thus not give it room enough to spin.

Time required to cover larva with earth, about six hours.

Time required for the larva to spin its cocoon so as to permit removing to another chamber, one and one half hours.

The color of the cocoons changes with age from a light gray to a pale reddish brown.

Although the matter seems not to have been considered by Lubbock and other investigators of ants, it is easy to understand that, as Mr. Goll says, the earth or some other material is necessary to furnish support for the cocoon. The naked larvæ lying about on the level floors of the chambers would have no means of supporting their silk in the air, nothing against which to spin. The majority of the lepidoptera and other insects go into the ground to pupate, with or without cocoons. Those which spin cocoons above ground generally wrap themselves up in leaves or seek crevices, corners or forks of branches, across which their outer network of threads can be fastened. It seems probable, therefore, that this curious habit of building earth cells for the pupating larvæ is no recently acquired instinct peculiar to the present species or its immediate relatives. The problem is as old as the social organization and nest-building habit of the ants, and the usual variety of solutions may be looked for among the many cocoon-making species.

The extensive labor involved in helping the young ants to pupate makes it easy to understand why so many members of the group have discontinued the process. The time used in making the earth cell is in some instances much greater than that reported by Mr. Goll. One of our larvæ was surrounded by a row of pellets of earth for over twelve hours, and, though lying quite still, was continually attended by three or four worker ants, waiting, as it were, for the final emergency. The use of earth in pupation constitutes a further reason why the earth and stone nests built into glass jar cages,* like those in which the ants were brought from Guatemala, afforded a better method of handling and observing them than the horizontal glass plates or plaster-of-Paris cells hitherto generally employed by

all the members of the species; otherwise this habit could scarcely have remained so long unknown. The occurrence of the kelep in Mexico is rendered somewhat doubtful, moreover, by the fact that the Mexican *Ectatomma ferrugineum* Norton, which Forel treats as a synonym of *E. tuberculatum*, may prove to be a distinct species. The National Museum has specimens from Mexico which agree well with Norton's description and figures, but offer appreciable differences from the keleps. The habits reported by Norton for his *E. ferrugineum* are also not those of the Guatemalan ants. "This species is found only in the *encinales*, or oak forests of the hot and temperate region, where it lives in little societies under the trunks of fallen trees."

* 'Habits of the Kelep or Guatemalan Cotton Boll Weevil Ant' Bull. 49, Bureau of Entomology, U. S. Dept. Agriculture, p. 6, Washington, 1904.

entomologists. In addition to much greater facility in capturing, transporting, feeding and keeping them moist, the ants are placed under much more natural conditions and may be expected to show more normal behavior.

O. F. Cook.

Washington, D. C.,
August 17, 1904.

IMPORTANCE OF ISOLATED REARINGS FROM CULICID LARVÆ.

The fact that four, five or more species of larvæ occur in association in the same pool, renders it difficult to separate the various species, especially as living larvæ resemble each other very closely. Particular attention has been paid to this phase of the subject during the present season with very gratifying results, as may be seen from the following:

A larva somewhat resembling and associated with *Culex impiger* presents marked differences in that the dorsal surface of the air tube is provided with a double row of hairs, each row consisting of about four tufts composed of a pair of weakly barbuled hairs. This is undoubtedly the larva which Messrs. Dyar and Knab* have confused with that of *Culex impiger*. From this larva a large, brownish-gray mosquito 6 to 7 mm. long, with the curved scales of the head white, was obtained. This species has been given the name of *Culex cinereoborealis* n. sp.

A larva somewhat resembling that of *C. impiger* was met with in a cold mountain pool at Elizabethtown, N. Y., June 9, adults emerging on the tenth and closely resembling those of *C. impiger*. The larva may be easily recognized by the conspicuous, triangular comb composed of about sixty rather large scales, each tipped with from four to seven stout, equal spines. The air tube is short, a little over twice as long as broad, slightly swollen at the basal third and bearing a double row of posterior pecten, each consisting of about twenty short, black, stout spines. The adult, *Culex lazarensis* n. sp., may be distinguished from *C. impiger* by its large size, it being 6 to 7 mm. long, and the vittate thorax with two dark lines. The wing of the female *C. lazarensis* is longer, the second longitudinal vein, particularly at its fork, is straighter, and the second fork cell is shorter and broader than in *C. impiger*. There are also marked differences in the male genitalia.

Another very interesting larva was met with June 14 in a cold mountain pool at Elizabethtown, N. Y., and may be easily recognized by the comb consisting of but six to seven thorn-like scales arranged in a curved line, with a large, finely setose, spatulate base and with a stout, apical spine. The air tube is about three times as long as wide, tapering regularly and with double posterior pecten on the basal third, each row consisting of twelve to fifteen closely set, stout spines, each bearing near the basal third one large and usually a smaller tooth. This larva produced an adult, *Culex aberratus* n. sp., which resembles *C. impiger* very closely and may be separated therefrom by the posterior cross vein being its own length or more from the mid cross vein, the thorax spotless, basal abdominal bands distinct, and the petiole of the first submarginal cell one half the length of the cell.

A long-tubed larva with a comb consisting of about eighteen triangular, stout, spined scales arranged in two or more rows, some of the scales having a very stout, terminal spine with smaller ones along each side, while others have the tips somewhat rounded and the spines more nearly of a size, was taken in a woodland pool at Karner, on May 10, adults emerging on the sixteenth. The air tube is fully five times as long as its greatest diameter, tapering somewhat regularly and with a slight bend and contraction near the middle. There are two rows of pecten, each consisting of about twenty-two closely-set teeth bearing at their bases usually two larger and three or four fine serrations. This species, *Culex fitchii* n. sp., is close to *Culex squamiger* Coq., and may be separated therefrom by the scales of the pleura being white and the posterior cross vein its own length from the one above. The basal segments of the antennæ are clothed interiorly with broad white scales; proboscis dark-brown, long; palpi dark brown, segments narrowly ringed at the base with white; occiput clothed with brown scales, with a row of silvery ones just above the eyes and

* *Ent. Soc. Wash. Proc.*, **6**: 144, 1904.

along the median line. Thorax with a broad, brown, central stripe bordered with a rather well-defined silvery, slightly broader, lateral stripe containing a few brown blotches. Pleura rather thickly clothed with patches of silvery white scales.

These species will be characterized more fully in a Bulletin of the New York State Museum soon to be issued.

E. P. FELT,
D. B. YOUNG.

NOTES ON SOCIAL AND ECONOMIC SCIENCE.

AGRICULTURAL ECONOMICS.

INTEREST in agriculture, like that in commerce and industry, tends more and more to take upon itself an international character. The correlation of international experience and the comparison of experiments, tendencies and economic conditions is one of the most fruitful fields of research, not only to the economist, but equally so to the technical agriculturist and to the practical farmer. Consumers generally are interested to the extent to which prices are affected by the favorable or unfavorable harvests in any particular country or group of countries. Any country whose system of production or distribution remains too far behind in the progress of scientific and practical economics must sooner or later lose its capacity to compete in the world market. The same is true of any particular crop, unless it be favored by special natural advantages. Just at this time much attention is being given to the study of the comparative strength of nations and the leading national systems of productive efficiency. It is hoped, therefore, that the following more or less specific accounts of agricultural conditions in the several countries represented may be deemed of timely interest and value.

SCIENTIFIC AGRICULTURE IN JAPAN.

A RECENTLY returned writer from the far east calls attention to the fact which students of oriental civilizations have so long overlooked, namely, the extent to which the Japanese especially have accepted the truth that the natural sciences lie at the basis of the material development of nations. In its own way Japanese husbandry seems to have worked out much that the experiment station has accomplished in the west. This writer (Mr. Harold Bolce, in *Booklover's Magazine*) calls the Japanese, with their 19,000 square miles of arable land, the most remarkable agricultural nation the world has known. "If all the tillable acres of Japan were merged into one field," he says, "a man in an automobile, traveling at the rate of fifty miles an hour, could skirt the entire perimeter of arable Japan in eleven hours. Upon this narrow freehold Japan has reared a nation of imperial power, which is determined to enjoy commercial preeminence over the world of wealth and opportunity from Siberia to Siam, and already, by force of arms, is driving from the shores of Asia the greatest monarchy of Europe.

"The secret of the success of the little Daybreak Kingdom has been a mystery to many students of nations. Patriotism does not explain the riddle of its strength, neither can commerce, nor military equipment nor manufacturing skill. Western nations will fail fully to grasp the secret of the dynamic intensity of Japan to-day, and will dangerously underestimate the formidable possibilities of the Greater Japan (the Dai Nippon) of tomorrow, until they begin to study seriously the agricultural triumphs of that empire. For Japan, more scientifically than any other nation, past or present, has perfected the art of sending the roots of its civilization enduringly into the soil.

"Progressive experts of high authority throughout the orient now admit that in all the annals of agriculture there is nothing that ever approached the scientific skill of Sunrise husbandry. Patient diligence, with knowledge of the chemistry of soil and the physiology of plants, have yielded results that have astounded the most advanced agriculturists in western nations."

CHANGES IN BRITISH AGRICULTURAL POLICY.

THE progress of scientific agriculture in England increasingly takes the form of assistance in effecting the adaptation of the industry to such crops as do not compete with

foreign imports to such an extent as is the case with grain and provisions. British agriculture has always been slow to specialize, hence the time-honored rotation system has often persisted until returns disappeared. The resulting decline in values had most serious consequences, social, economic and political. It forced population into trade and industry, into cities and into the colonies, until the greatest drawback to successful agriculture is the scarcity of labor. This in turn has given rise to seasonal migrations of rural laborers to and from various sections of the British Isles. It has increased the burden of taxation on rural property, and with the decline of values and rural incomes, has materially lessened the revenue of the national treasury from this important source of public income. Finally, it has given rise to the most noteworthy political agitation since Cobden's time in the form of Mr. Joseph Chamberlain's campaign for the reorganization of the whole imperial fiscal system on a basis of preferential duties on trade between the mother country and the colonies, as against all other countries. Mr. Chamberlain has always regarded domestic agriculture as a neglected factor in British economic policy. His fiscal scheme has in view the restoration of this aspect of national enterprise, much as Germany and France do now, and also the development of colonial sources of food-stuff supplies, so as to decrease the degree of dependence on Russia, the United States and Argentina.

Below is a report on 'Decline in English Farm Values,' as transmitted by the United States Consul Mahin, of Nottingham, under date of July 12, 1904, relating primarily to Lincolnshire. While this locality has geographically a rather exceptional position on the east coast on account of its remoteness from large markets, it is nevertheless a representative rural county, and is in that respect typical of rural tendencies generally.

The excessive importation of food products from foreign countries, the report states, is charged with direct responsibility for a great decrease in the value of farm lands in this county. Recent investigations of values of agricultural land in Lincolnshire disclose an extraordinary decline; possibly, however, not typical of all England, for it is believed that in the county named the depression is particularly acute. It is stated that in some instances persons who a few years ago invested their all in land, and also mortgaged it to raise money to complete the payments, find now on attempting to sell that they can not get even the amounts advanced on the mortgages.

Many instances of remarkable decreases in value are given. In one case where a farm of 315 acres, which cost $74,000, was offered at auction the highest bid was $20,000. The owner of an estate which cost him nearly $300,000 is now vainly trying to sell it for just one half of that price. An estate of 628 acres, which sold in 1901 for $110,000, was in May of this year valued for probate at only $43,000. In comparison with years in the distant past the situation appears no better. A farm of 134 acres, purchased in 1881 for $30,000, sold for only $15,000 in 1901, and would probably bring even less to-day. Thirty-four acres, costing $8,000 in 1860, recently sold for $2,500. A tract of 103 acres brought over $30,000 in 1828, and a mortgage for $25,000 was placed on it; this year, in April, it sold for less than $14,000. But the severest phase is the decline in the values of small farms of from 30 to 100 acres, the property of persons who can least afford the loss they suffer. Many cases are given where sales were for one half and even one third the purchase price, and often the selling price failed to cover the mortgage given upon the property.

Rent rolls are also suffering. Instances are cited where they have decreased one half and more. In one case a renter of a farm increased his holdings by leasing an adjoining tract of the same size, and he now pays less rent for the two than formerly for the one farm. In these cases the chief sufferers are those who can best afford the loss.

The cases cited are all in Lincolnshire. The great depression there has caused the farmers to look about for other sources of revenue than those which are so disastrously affected by foreign imports, and just now many are turning to strawberries. Fields hitherto covered with small-grain crops are this year devoted to strawberries. The daily yield of the county is estimated at 250 long tons. Special trains are necessary to carry the berries to market—two or three a day, of 30 to 35 cars, each car holding nearly 1,000 six-pound baskets of the fruit.

Flowers are also being cultivated in Lincolnshire to a greater extent than ever before. Whole fields, in some cases extending as far as the eye can reach, are devoted entirely to flowers. They are packed in boxes, and it is said that the ship-

ment of 10 tons a day is not an unusual record at a single railway station.

Celery and carrots are also being grown in Lincolnshire to an extent never before thought of. The former yields $150 to $300 to the acre, while small grain yields only $40 to $50. But unfortunately, only a certain character of soil is favorable to celery culture, or the temptation would be to turn Lincolnshire into one vast celery bed. Much attention is also given to carrots in the attempt to retrieve losses due to the flood of imports. An acre will produce from 15 to 25 tons, at $10 a ton. The process of seeding is novel. The farmer mixes sand with his carrot seed, to prevent its being too thickly sown and thus being in large part wasted. A field, then, somewhat resembles a desert, across which the wind would whirl clouds of sand did not the farmer slightly ridge and then roll the field, checking the wind's effect.

Whether the experiment of substituting strawberries, celery and carrots for small grain, and in some cases for dairy products, will sensibly relieve the distress in Lincolnshire is a question which may not be answered for several years.

These developments raise the question whether agriculture in the eastern portion of the United States could not profit by Lincolnshire's experience. New England and the west are related much as Lincolnshire is to foreign competition. Specialization in non-competitive products has, with the progress of trucking in the south and of dairying in the west, possibly narrower limits than formerly. Nevertheless, the trucking seasons are not simultaneous, comparing the north with the south. Likewise there are lines of production in which the east may successfully compete with the west. Here is a line of inquiry on the subject of sectional farm policy in which much might be learned by collating the experience of other countries and studying in detail the local conditions, with a view to defining what might be called non-competitive spheres of production. Have the state and federal departments of agriculture given adequate attention to this phase of the subject?

THE AGRICULTURAL POLICY OF GERMANY.

The Contemporary Review has an exposition of the present trend of Germany's economic discussion in relation to agriculture, the history of which discussion the author, Edward Bernstein, traces from List's time (1789–1846) down to the present.* List was a German-American, it is well to recall, who was associated with the beginnings of the anthracite coal industry, afterwards was vice-consul of the United States in Germany and earlier (1817–1819) professor of political economy in Tübingen University. He died by his own hand in 1846. His great work, 'The National System of Political Economy,' was born, so to speak, out of his American experience, and was intended to put into scientific outline the policy which should guide the economic development of this country and Germany in their relations to Great Britain, then nearing the zenith of her industrial ascendency.

The commercial policy of the United States is now at the turning of the ways, and recurrence to List's famous theory of educational duties, *i. e.*, that protective duties must be confined to educating the manufacturing classes of the country up to the standard of their advanced competitors, is eminently timely. For Germany, List advocated an *agricultur-manufactur-Staat*, an economic system best represented by the home market idea. In List's time this meant duties on manufactured imports; now it means duties on agricultural products. Germany is becoming more and more a manufacturing country—*ein export industrie Staat*. The protection of agriculture, it is held by such professors as Wagner and Oldenburg, is necessary for broadening and deepening the domestic basis of the industrial structure, which would otherwise be dependent on the exigencies of the foreign market, with great danger to the state, especially in time of war.

The real motive for this policy in the economic thought of Germany lies deeper than the question of markets. The secret is sociological, and has its root in the fear that, with the urban growth of population, the decreased income value of landed estates and of agriculture generally, the landed nobility and with them the rural voter, must disappear from the social constitution of national society, leaving the control of the machinery of the state and

* 'German Professors and Protectionism,' *Contemporary Review*, July 1, 1904.

the execution of the mission of the empire, to the two warring camps of the capitalist class on the one hand and the social democracy on the other. The growth of industrial as against rural population means progress of these two powers. Hence higher duties on agricultural imports are required to maintain the balance of class power, capitalist, wage-class and agrarian. One may read here the effort of the privileged classes of German society to equalize more nearly these three economic classes as the three points which must determine the plane of well being of the privileged interests. The truth seems to be that Wagner's alarms are ill-founded. The landed gentry's estates, those of the 'gentleman farmer' who spends much of his time and substance away from his estates entrusted to second hands, comprise the weak spot in German agriculture. It is not protection so much as a deeper sense of economic responsibility, on the part of this class, that German agriculture needs. "The demonstration that the German peasantry can not exist with prices as they are is extremely specious. In some districts they may groan under hardships, but in others they do pretty well. Growing towns and increasing industrial districts furnish splendid markets for them; it is in the mainly agricultural and not in the mainly industrial districts that the agricultural population decreases. The tide of immigration is strongest where the big estates for the landed gentry and semi-feudal nobility prevail."

John Franklin Crowell.

COOPERATION IN SOLAR RESEARCH.

At its last annual meeting, the National Academy of Sciences appointed a committee on solar research, consisting of George E. Hale, chairman, W. W. Campbell, S. P. Langley, A. A. Michelson and C. A. Young. At the invitation of this committee, various societies in Europe and the United States have appointed similar committees as follows:

England—Committee of the Royal Society: The president of the Royal Society (Sir William Huggins), the Astronomer Royal (Mr. W. H. M. Christie), Sir Norman Lockyer, Professor A. Schuster, Mr. H. F. Newall. *Committee of the Royal Astronomical Society:* The president of the Royal Astronomical Society (Professor H. H. Turner), with others to be appointed. Professor Turner, with others not yet named, will represent the two societies at the conference of delegates.

France—Committee of the Société Française de Physique: M. Henri Poincaré, M. Charles Fabry, M. A. Perot, and others not yet named. The views of the French spectroscopists on the question of standard wave-lengths are being ascertained by the committee, and MM. Fabry and Perot have been requested to prepare a memoir on the subject for presentation to the conference of delegates, where the society will be represented by M. Poincaré and others.

Germany—Committee of the Deutsche Physikalische Gesellschaft: Professor Ebert, Kayser, Kreusler, Lummer, Pringsheim, Runge, Straubel, Wilsing. The names of delegates have not yet been announced. Professor Kayser is preparing a memoir for the conference on the subject of standard wave-lengths.

Holland—Committee of the Royal Academy of Sciences, Amsterdam: Professors Kapteyn and Julius. Professor Kapteyn will represent the academy at the conference of delegates.

Italy—Committee of the Societa degli Spettroscopisti Italiani: Professor Tacchini, Professor Riccò, and others to be appointed. Professor Riccò will represent the society at the conference.

Russia—Director Backlund will probably attend the conference as the representative of Russia. Committees of the Russian societies will be appointed later.

United States—Committee of the National Academy of Sciences: Professor W. W. Campbell, George E. Hale, A. A. Michelson, S. P. Langley, C. A. Young. *Committee of the American Physical Society:* Professors J. S. Ames, Henry Crew, Percival Lewis, C. E. Mendenhall, E. F. Nichols. *Committee of the Astronomical and Astrophysical Society of America:* Professors E. B. Frost, C. G. Abbott, L. A. Bauer, C. D. Perrine, F. L. O. Wadsworth.

Other societies which were invited to appoint committees have not yet been heard from.

Conference of Delegates.—The conference of delegates will meet in St. Louis on Thursday, September 22, in conjunction with the International Congress of Arts and Science. Members of the committees who expect to attend the conference are requested to notify the undersigned.

The principal topics for discussion at the conference of delegates will probably include the following subjects: (1) Plans for cooperation in solar research, and the preparation of a general program of observations; (2) formation of an international committee to conduct this work; (3) adoption of a system of standard wave-lengths.

INVITATION TO THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE.

THE organizers of the congress, to be held at the universal exposition, St. Louis, on September 19–25, 1904, desire to invite the special attention of professors and men of science in the United States and Canada to the unexampled opportunity which it offers to meet and hear a great number of eminent men of learning. It is expected that more than three hundred eminent scholars of Europe and America will deliver discourses in the various departments and sections of the congress, and that several hundred shorter communications will be made by those present.

It is the desire of the directors of the fair and of all concerned in the organization that professors and instructors in our colleges and universities, and members of the learned professions generally, shall, so far as possible, do honor to our distinguished visitors by attending the congress. For this no fee is charged and no formality is necessary except enrolment on arrival. It is, however, desirable to apprise Mr. Howard J. Rogers, director of congresses, Universal Exposition, St. Louis, Mo., in advance, what departments of the congress one desires to attend. A program of its proceedings, with such other instructions as may be necessary, will be sent by Mr. Rogers on application.

NICHOLAS MURRAY BUTLER,
Chairman of the Administrative Board.
SIMON NEWCOMB,
Chairman of the Organizing Committee.

SCIENTIFIC NOTES AND NEWS.

THE nomination of Dr. George H. Darwin, Plumian professor of astronomy and experimental philosophy at Cambridge, as president of the British Association for the Advancement of Science was confirmed by the general committee at the Cambridge meeting, and he will preside at the meeting to be held next year at South Africa. Dr. John Perry, professor of mechanics and mathematics at the Royal College of Science, London, was elected treasurer in succession to Professor Carey Foster. The association will meet in York in 1906. It held its first and its fiftieth meeting at York, and two years hence will celebrate its seventy-fifth anniversary.

ON the occasion of the meeting of the British Association at Cambridge the university conferred its doctorate of science on the following men of science: Johan Oskar Backlund, director of the Central Nicolas Observatory at Poulkovo; Henri Becquerel, professor of physics in the École Polytechnique, Paris; Julius Wilhelm Brühl, professor of chemistry in the University of Heidelberg; Adolf Engler, professor of botany in the University of Berlin; Paul Heinrich von Groth, professor of mineralogy in the University of Munich; Albrecht Kossel, professor of physiology in the University of Heidelberg; Henry F. Osborn, professor of zoology in Columbia University, New York; Nikolaas Gerard Pierson, sometime Prime Minister of the Kingdom of the Netherlands; Vito Volterra, professor of applied mathematics in the University of Rome; Sir David Gill, F.R.S., his Majesty's astronomer at the Cape of Good Hope; Alfred William Howitt; Sir Norman Lockyer, F.R.S., director of the Solar Physics Observatory, South Kensington; Major Percy Alexander MacMahon, F.R.S., late Royal Artillery, formerly professor of physics, Ordnance College, Woolwich; Sir William Ramsay, F.R.S., professor of chemistry, University College, London; Arthur Schuster, F.R.S., professor of physics in the Victoria University of Manchester; Sir William Turner Thiselton-Dyer, F.R.S., director of the Royal Botanic Garden, Kew.

THE Seventh International Zoological Congress will meet in Boston in 1907 under the presidency of Mr. Alexander Agassiz.

Beloit College conferred at its recent commencement the degree of doctor of laws on Professor George E. Hale, director of the Yerkes Observatory, and on Professor Rollin D. Salisbury, head of the department of geography of the University of Chicago.

The gold medal of the American Geographical Society has been presented to Dr. Sven von Hedin by the United States Ambassador at Stockholm.

Dr. N. L. Britton, director of the N. Y. Botanical Garden, and Dr. J. N. Rose, of the U. S. National Museum, have taken up the study of the Cactaceæ. They propose to gather large living collections both at New York and Washington, much as they have done with the Crassulaceæ, and to continue their studies for a series of years, basing descriptions largely on living plants. Extensive field work will be done, especially in Mexico, and the earnest cooperation of botanists traveling in the southwest is solicited. The National Museum will gladly furnish means for sending material to Washington.

At the meeting of the board of regents of the University of California held on August 9, 1904, Professor C. A. Kofoid, of the department of zoology, was granted leave of absence from the university until March 15, 1905. Professor Kofoid will have charge of the plankton work of the Tropical Pacific cruise of the *Albatross*, to be conducted by Mr. Alexander Agassiz during the coming winter.

Mr. C. F. Austin, of the Maryland Agricultural College, has been appointed agriculturist at the central Cuban station.

Professor F. Kohlrausch has retired from the presidency of the German Reichsanstalt.

Professor W. Förster, who celebrated the fiftieth anniversary of his doctorate on August 5, will retire from the directorship of the Berlin Observatory on October 1.

Dr. Karl von Voit, of the Physiological Laboratory at Munich, celebrated, on August 8, the fiftieth anniversary of his doctorate.

Mr. S. A. McDowell, B.A., Trinity College, Cambridge, has been appointed assistant to the superintendent of the Museum of Zoology.

Dr. H. C. Müller, vice-director of the experiment station at Halle, has been appointed director of the chemical control station at the same place, to succeed the late Dr. L. Bühring.

Dr. K. Windisch, of Berlin, has been appointed director of the agricultural institute at Hohenheim.

Dr. Th. Loesner has been appointed curator in the botanical museum of Berlin University.

At a recent meeting of the state board of agriculture an appropriation was voted for a geological survey of the mineral resources of Virginia. The survey will be conducted jointly by the state board of agriculture and the Virginia Polytechnic Institute. Dr. Thomas L. Watson, professor of geology in the Polytechnic Institute, was appointed geologist-in-charge of the survey.

The museum of the University of Michigan has sent a party to the Porcupine Mountains and Isle Royale in Northern Michigan. The object of the trip is to make a preliminary ecological survey of the fauna and flora of the areas visited and to collect specimens for the museum. The field expenses of the party are met by the combined gifts of Mr. Bryant Walker, of Detroit, and the Hon. Peter White and Mr. N. M. Kaufmann, of Marquette. The party will spend about two months in the field.

We credited last week to the daily papers the statement that Professor Frederick Starr, professor of anthropology at the University of Chicago, would resign and would make an extended expedition to Japan and China. We are informed that this statement is entirely incorrect.

Dr. H. H. Turner, Savilian professor of astronomy in the University of Oxford, gave six illustrated lectures on astronomical discovery, and Professor Hugo de Vries, professor of botany at the University of Amsterdam, gave four lectures on the mutation theory at the University of Chicago during the present summer.

Stanford University publishes the bibliography of its staff in zoology, professors and students to 1903. In the list are 127 titles of papers by Professor Charles Henry Gilbert, 4 by Associate Professor George Clinton Price,

7 by Associate Professor Harold Heath, 19 by Assistant Professor John Otterbein Snyder, 21 by Curator Edwin Chapin Starks, 3 by James Francis Abbott, 3 by Frank Cramer, 9 by Walter Kenrick Fisher, 13 by Henry Weed Fowler, 1 by Arthur White Greeley, 28 by Joseph Grinnell, 1 by James Alexander Gunn, Jr., 2 by Flora Hartley (Mrs. C. W. Greene), 4 by Edmund Heller, 1 by James Franklin Illingworth, 1 by Richard Crittendon McGregor, 1 by Charles James Pierson, 4 by William Weightman Price, 4 by Cloudsley Rutter, 2 by Norman Bishop Scofield, 3 by Alvin Seale, 4 by Robert Evans Snodgrass, 2 by John M. Stowell and 4 by John Van Denburgh. The publications of President Jordan comprise 433 titles. The publications of Professor V. L. Kellogg, of the separate chair of entomology, are not included in this list.

THE centenary of the discovery of morphine by Adam Serteurner has recently been celebrated at Paderborn in Westphalia.

A STATUE of Sir Thomas Browne, by Mr. Henry Pegram, will be erected at Norwich.

MR. FRANK GUSTAVE RADELFINGER, assistant professor of mathematics in George Washington University and a practising patent attorney, known for his work on differential equations, died at Washington on August 15 at the age of thirty-four years.

THE Rev. Dr. Charles W. Shields, professor of the harmony of science and revealed religion at Princeton University since 1865, died at Newport on August 25, at the age of seventy-nine years.

PROFESSOR ANTONI DRASCHEQ, a member of the Austrian sanitary council, celebrated for his investigations in the disease of cholera, has died at Vienna.

THE death is also announced of Christof von Sigwart, professor of philosophy at Tübingen, and of the Rev. Dr. H. P. Gurney, principal of the Durham College of Science and professor of mathematics, who was killed by an Alpine accident on August 13.

As we have already announced, the Society of Chemical Industry will meet in New York, beginning on September 7. About one hundred foreign members are expected. The meeting will open with a reception at the Chemists' Club on Wednesday, and the regular sessions will begin at Columbia University on the following day. Elaborate arrangements have been made for the entertainment of the visitors, who will be taken by special train to the chief centers of chemical industry of the country and to the International Congress of Arts and Science at St. Louis.

THE Belgian Academy of Sciences offers a prize of 1,000 francs for the best research on the development of Amphioxus.

THERE is being held this month at Paris an International Exposition of Hygiene.

A CHEMICAL laboratory for the examination of imported food products will be opened in the Appraiser's Stores Building of the Treasury Department in New York by the Department of Agriculture on September 5. Five expert chemists will be engaged.

THE Antarctic relief ship, *Terra Nova*, has returned to England, and the first instalment of the specimens of the National Antarctic Expedition has arrived at the British Museum. The British Museum will undertake the classification, description and publication of the biological and geological collections.

ACCORDING to the *Consular Reports* the board of directors of the German Colonial Society has appropriated $7,140, to be paid in three yearly instalments, as an aid to the scientific experiment station which Dr. Hermann Meyer is soon to establish in the German colony of Neu-Würtemberg, Ria Grande do Sul, Brazil. This station is being organized for the purpose of making a large number of agricultural experiments. It is hoped that it will help the German colonists of the southern States of Brazil to secure better returns in the way of crops, which as yet, because of improper cultivation, have not been entirely satisfactory. About 250 acres, near the town of Elsenau, have been secured for the experiment station, and on this a number of houses will be erected, which will serve as workshops and dwellings for those engaged in conducting the experiments.

THE New York *Times* states that the Interstate Park, for which the people of New York and New Jersey have had to fight so hard, is now an assured fact. It will extend fourteen miles along the west bank of the Hudson. This is the result of the agitation against the blasting away of the Palisades, which tower to the height of from 300 to 600 feet from Fort Lee to Piermont. Already the commission has expended $344,264 in laying out this park. In order to carry out the plans of the commission it will be necessary to acquire 175,000 acres, but there is a large sum still in the treasury, and the two states have agreed to bear an equal amount of the additional expense that will be necessary to make this park one of the most beautiful in the country. Work is just being begun on a boulevard that will extend the entire length of the park.

OUR consul at Frankfort writes to the Department of Commerce that there are 220 agricultural cooperative associations in Russia. Some of them receive subsidies from the government or the district council. These associations purchase, at wholesale, agricultural implements and machinery, seeds, breeding stock, etc., which are sold on credit or on the instalment plan to the individual farmers. Agricultural exhibitions are held and lecturers are employed who go from place to place instructing the farmers in all branches of husbandry. Grounds are also set apart for experimenting by cultivating new plants. In many other ways the cooperative associations result beneficially for the Russian peasant.

UNIVERSITY AND EDUCATIONAL NEWS.

WELLESLEY COLLEGE has received $10,000 and a collection of paintings by the will of A. W. Stetson, of Braintree.

COLUMBIA UNIVERSITY will celebrate the hundred and fiftieth anniversary of its foundation as King's College on the last four days of October. There will be a public reception on the afternoon of Friday, October 28, with all the university buildings open for inspection, and receptions within the larger reception, at which the offiers of the different departments will entertain. On Monday morning corner stones of four new buildings will be laid: the university chapel, the School of Mines building, Hartley Hall and a second university dormitory; and if the completion of the building is accomplished, the new Thompson physical education building of Teachers College will be dedicated. On Monday afternoon there will be the formal university convocation with a commemorative address by President Butler. There will also be lectures by foreign guests, but the details have not yet been announced.

ACCORDING to the daily papers the treasurer of the Catholic University, Washington, has become financially embarrassed. It is said that he has invested $876,000 of the university's funds for it, paying the university 6 per cent. interest. He gave on July 25 a deed of trust for this amount to the university, but several banks have filed a petition in bankruptcy against him and seek to set aside the deed of trust as void.

DR. EDMUND J. JAMES, president of Northwestern University, has been elected president of the University of Illinois, succeeding Dr. A. S. Draper, now superintendent of State Instruction in the State of New York.

ELIAS P. LYON, assistant professor of physiology in the University of Chicago, has accepted the professorship of physiology in St. Louis University. Other members of the staff will be C. H. Neilson, associate professor of physiological chemistry and O. H. Brown, instructor in physiology, both coming from the physiological department of the University of Chicago.

MR. CHANCEY JUDAY has been appointed instructor in zoology at the University of California.

MR. LOYE H. MILLER has been appointed teacher of biology in the State Normal School at Los Angeles, California.

DR. ROBERT E. MORITZ, of the University of Nebraska, has been elected professor of mathematics in the University of Washington to succeed Professor Arthur Ranum who has resigned.

DR. BÖTTGER, docent for physical chemistry in the University of Leipzig, has been called to the Massachusetts Institute of Technology.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 9, 1904.

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STATE ICHTHYOLOGY OF MASSACHUSETTS.

I.

THE history of the ichthyology of Massachusetts has never been written and a sketch of such appeared to me to be the best and most seasonable response I could make to the invitation to address the investigators and students assembled at the headquarters in Massachusetts of the United States Fish Commission. The history is an interesting and a rather remarkable one. Of course, in the time allotted for an address, only the salient features of a long history can be given and many minor communications and even popular works relating to the ichthyology of the region in question must remain unnoticed. The room is requisite for a neglected subject. We are often curious to know something about the personality of the men whose work we consider and such information is generally difficult for the scientific student to obtain. Of several of the old and departed writers on the fishes of Massachusetts notices will be now given, and when reference is next made to their writings, perhaps it may be done with a new interest and better means of judging their work.

The history of Massachusetts ichthyology begins early in the history of the United States—earlier even than any set-

* An address delivered at Woods Hole, before the Marine Biological Laboratory, on the evening of August 3, 1904.

The early history may be found given at greater length in the new edition of Goode's 'American Fishes,' edited by Gill and published by Dana Estes & Co., of Boston (1903).

tlement by English in the state. Captain John Smith, who acquired celebrity in connection with a more southern province, having induced certain London merchants to furnish him with two vessels for exploration of the New England coast, in the spring of 1614, visited and made a sketch map of part of the coast of territory granted to the Plymouth Company. In 'A Description of New England,' published in 1616, he enumerated the fishes. Excluding the 'whales, grampus, porkpisces' or porpoises, and the shell-fish, the names of sixteen were mentioned—'turbut, sturgion, cod, hake, haddock, cole, cusk, or small ling, shark, mackerrell, herring, mullet, base, pinacks, cunners, perch, eels.' In another paragraph, we are told, 'much salmon some haue found vp the Riuers, as they haue passed.' Smith claims for the cod that 'each hundred is as good as two or three hundred in the *New-found Land*. So halfe the labor in hooking, splitting, and turning, is saued.' He in short takes a very practical view of the subject, and has quaintly expressed it. "And is it not pretty sport," says he, "to pvll vp two pence, six pence, and twelue pence, as fast as you can hale & veare a line? He is a very bad fisher, cannot kill in one day with his hooke & line, one, two, or three hundred cods: which dressed & dryed, if they be sould there for ten shillings the hundred, though in England they will giue more than twentie; may not both the seruant, the master, & marchant, be well content with this gaine?"

Doubtless such a report had some influence in determining the trend of immigration into Massachusetts, and one of the newcomers, 'a reverend Divine' (Francis Higginson), was ready to confirm Smith's praise, and wrote, in 1630, 'The aboundance of Sea-Fish are [*Sic*] almost beyond beleeuing, & sure I should scarce haue beleeued it except I had seene it with mine owne Eyes.'

Numerous other chroniclers testified to the richness of the New England seas and gave lists of the fishes. The most lengthy of the lists is that in 'An Account of two voyages to New England' by 'John Josselyn Gent.,' published in 1675; this includes sixty-five names, of which forty-six are those of what we would now call fishes. This list, which is simply a nominal one, supplements slight descriptive notices of eight others which precede it.

It would scarcely repay us, on the present occasion at least, to give further attention to such lists, but the common names introduced by the early settlers furnish an interesting theme for consideration.

The known fishes of England are few in number, and the emigrants knew few of them even, and knew those few very imperfectly. When the earliest of those emigrants lived, naturalists even had no idea of the diversity of animal life or the facts of geographical distribution. For instance, John Ray, the best naturalist of his age, who flourished in the last quarter of the same century, thought that there were only 'near 500' fishes in the whole world! Naturally, the common people were unprepared to appreciate the diversity of the new life which they were to see.

The immigrants were astonished at the abundance of the fishes about their new home. To these numerous fishes they transferred names of English species with which they were more or less familiar. On account of the greater number of species, or at least of genera, common to the two countries, the emigrants from Old England to New England were not very far astray in naming many of the fishes of their new home; but as they, or their successors, wandered farther and farther from their old home, they made many mistakes. A

few examples of the very many will illustrate.

Among the most common of the English fishes are the cod, perch, bass and trout. The immigrants into Massachusetts applied these names to fishes of the same genera as the originals, or to very closely related genera, but mostly of different species. As population extended into remoter regions and stranger faunas, the meager supply of names had to be doled out to forms quite unlike those to which they had been originally applied.

Cod was used in a few cases for the only fresh-water species of the same family—*Lota maculosa*, otherwise called burbot; but when the Americans reached the Pacific coast, not finding the true cod, they misapplied its name to fishes of very different families, although generally with qualifying prefixes. Thus, the young of the boccaccio (a scorpænoid fish, *Sebastodes paucispinis*), which were caught at the wharves of San Francisco, were dubbed tom-cods; a hexagrammoid fish (*Hexagrammus decagrammus*), also inaptly named spotted rock trout, was by others called rock cod; another species (*Ophiodon elongatus*) was designated as the cod or 'codfish where the true cod is unknown,' and, where it is known, the cultus cod.

Perch was subject to much greater misuse. In England the name is specifically applied to a well-known fresh-water fish (*Perca fluviatilis*). The immigrants into New England found a fish almost undistinguishable from it, and properly gave it the same name. Others gave it to fishes having no real resemblance; such is the one called also white perch along the Atlantic coast, which is a bass (*Morone americana*); others are sciænids, as the silver perch (*Bairdiella chrysura*), the gray perch (*Pogonias chromis*) and the white perch of the Ohio River (*Aplodinotus grunniens*); another, the red perch (*Sebastes marinus*), is a scorpænid; and still another, the blue perch (*Tautogolabrus burgall*), a wrasse or labrid. The name is also given in some places to various species of a family peculiar to America, the centrarchids, and among them to the black basses and the sunfishes. Along the Pacific coast it is given to viviparous fishes or embiotocids, especially, in California, to the alfione (*Rhachochilus toxotes*), and in Oregon and Washington to another, likewise miscalled porgee (*Damalichthys argyrosomus*). The Sacramento River embiotocid (*Hysterocarpus traskii*) is called river perch or simply perch.

Bass is applied to so many different species—a score and more—that we can not spare the room to enumerate them. In England it is the proper name of a marine fish common only along the southern coast, formerly called *Labrax lupus*, but now named *Dicentrarchus labrax*. A related species, though of a different genus, was found by the new settlers of Massachusetts and New York, and quite properly called bass or striped bass; it is the *Roccus lineatus* of modern ichthyologists. There are several other species, including the white perch, also entitled to the name. All others are quite remote from the true bass—even the black basses. These last, however, must retain the name, and it might be better to always use the hyphenated form, *i.e.*, black-bass.

Trout is another of the English names variously misapplied. In the old country it is given to a single species generally distributed through the island in clear cold streams. The Pilgrims found in similar streams in Massachusetts a fish somewhat like it, and called it by the same name, although if good Isaak Walton or some other angler had been among them, he might have told them it was not a trout, but a char. Others found in Maine landlocked salmon and in various large lakes

another good-sized salmonid (*Cristivomer namaycush*), and applied to them also the name of trout, but often with a qualifying prefix, as schoodic, or sebago trout, and lake trout. The old specific name was thus applied to representatives of three distinct genera; but the offense was venial, as the genera are closely related and belong to the same family. But this was not the case with others. Settlers in troutless southern states, bound to give the name to some fish, gave it to the centrarchoid fishes generally known as black-basses. This perversion even found its way into scientific literature, for 'Citizen Bosc,' French consul at Charleston a century ago, sent specimens to Paris, with the information that it was called trout, and 'Citizen Lacépède' gave it the specific name *salmoides*. Along the southern coast, too, the name trout or sea trout was given to sciænoid fishes of the genus *Cynoscion*. When the Americans reached the Californian coast they found certain fishes of a peculiar family (hexagrammids), not at all like trout in shape or fins, but spotted, and these also they called trout. Still another fish, found in the Gila River, a slender large-mouthed cyprinid, *Gila gracilis*, was called by early explorers trout, and still bears the name.

But this is not all, or the worst! These old names are not only widely scattered; they may be more or less concentrated on one fish. We need only take those already considered as instances.

Cod and trout are given to the same hexagrammids along the Pacific coast. The *Hexagrammus decagrammus*, for instance, is called rock cod about Puget Sound, and rock trout and sea trout at San Francisco. Bass may also be given in some places, as a somewhat related fish, less like a bass (*Sebastodes melanops*), is called black-bass.

Trout, bass and perch are also given to the black-basses, as already indicated, in various places in the southern states.

Our forefathers likewise brought with them fish-names which have become almost obsolete in England, but which have entered on a new life in the new land. One such is alewife (*Pomolobus pseudoharengus*), so familiar in connection with the enormous schools of the clupeid, so called, which enter the rivers of New England. So entirely has the name been submerged in England, so prominent has it become in the United States, that it has been supposed by some lexicographers to be of American origin. For example, in that monument of industry and erudition, 'A New Dictionary on Historical Principles [etc.], edited by James A. H. Murray [LL.D., etc.], with the assistance of many scholars and men of science,' the etymology of alewife is given in the following terms: "Corrupted from 17th c. *aloofe*, taken by some to be an American-Indian name; according to others a literal error for French *alose*, a shad. Further investigation is required." (It is defined 'An American fish [*Clupea serrata*] closely allied to the herring.') Further investigation has demonstrated that the supposed etymology is based on errors of several kinds. Too much space would be required to give the details, and those especially interested may find the record (by the present writer) in that receptacle of notes curious and philological entitled, 'Notes and Queries' (9th s., VIII., 451-452). In brief, the status is this:

First, alewife is not only an old English name, but still survives in southwestern England, as attest the works of Couch and Day on English fishes. *Second, alose*, as such or with literal modifications, has existed as an English word, in certain localities, for centuries, although it was doubtless derived from the French through the Normans. In the same year, 1620, that the 'Pilgrim Fathers' left Old England and reached New England, one Venner published the statement that 'The *allowes*

is taken in the same places that sammon is.' *Third, aloofe* is simply the result of a printer's mistaking an old-fashioned median *s* for an *f*. The second John Winthrop sent to the Royal Society an article on 'maiz' which was published in 1679 in the *Philosophical Transactions* (XII., p. 1066). In that article he noted the coincidence of the planting of corn by the Indians and the 'coming up of a fish, called *aloofe*, into the rivers.' Of course that fish could only have been the one called by his contemporaries, Morton, Wood and Josselyn, *allize* and *alewife*. *Fourth, alewife* is doubtless a mere variant—an accommodative form, perhaps—of the word variously spelled in olden days *alose, aloose* (the *oo* has the value of a prolonged *o* sound), *allowes, allow, alice, olafie* and *oldwife*. *Fifth,* the Narragansett Indian name of the alewife was (in the plural) *aumsuog,* according to Roger Williams, or *umpsauges,* according to Stiles. *Sixth,* the current English name of one of the shads is *allice* or *allis* shad.

Let it not be inferred from this that disrespect is held towards the great New English dictionary. Even the very best are liable to err, and the dictionary is not exempt from the liability, although it does rank among the 'very best' and most useful of works; it may be added, too, that an American book to be noticed later on—Smith's 'Natural History of the Fishes of Massachusetts'—had some share in misleading the learned Englishmen. Smith says (p. 164): 'It has been suggested that alewife is derived from the Indian word *aloof*—signifying a bony fish.'

Naturally, the Indians had names for all fishes of economical value, and even for others. A few only, however, were adopted by the new colonists, and those only in forms considerably different from the originals. Such are, besides menhaden, scup, chogset, tautog and squeteague, still more or less used along the Atlantic coast, namaycush, masamacush, winninish (ouananiche), togue, siscowet and cisco in the interior, and stit-tse, nissnee, quinnat, kisutch and eulachon or oolachan along the Pacific coast.

II.

The first special memoir of a really scientific nature on the fishes of our region was communicated in 1794 by William Dandridge Peck, but not published till 1804 in the *Memoirs of the American Academy of Arts and Sciences.* Peck was then resident at Kittery, N. H., and his memoir was entitled 'Description of Four Remarkable Fishes, taken near the Piscataqua in New Hampshire.' He aptly prefaces his article with the remark that 'that part of the Atlantic which washes the extensive sea coast of Massachusetts, affords a considerable number of fishes, many of which are but little known' and, after some further remarks, proceeds to describe the species.

William Dandridge Peck was born in Boston, Mass., May 8, 1763, graduated at Harvard in 1782, and subsequently served for some years 'in a counting house in Boston.' "He was an ingenious mechanic, and made a microscope and many other delicate instruments." At the same time he was a devoted student of natural history and especially of ichthyology. His studies were crowned in 1805 by the reward of a professorship of natural history in Harvard College and this was held till his death. He died October 3, 1822.

Let us now return to his memoir. As already noted, the species were four. The first was identified by him with the *Ophidium imberbe* of Linnæus; the second received a new name, *Stromateus triacanthus;* the third also has a new name, *Blennius anguillaris,* and the fourth was considered to be specifically identical with the *Cyprinus catostomus* of Forster. Peck's descriptions were very good—for the time at

least—and by them his species can readily be recognized.

The first species is clearly the one later (1839) named *Cryptacanthodes maculatus* by Storer; Peck's misidentification undoubtedly was very bad, but he manifested a better appreciation of the relationship of the species than did Storer. The *Ophidium imberbe* of Linnæus was primarily based on the common gunnell of Europe, *Pholis gunnellus*. Apt as Peck's description was, however, Storer did not recognize his fish. Dekay later (1842) equally failed to recognize it, but, concluding that it could not be the *Ophidium imberbe* of Linnæus, referred it to the genus *Fierasfer* and called it *'Fierasfer borealis?'* The name was new, and by the interrogation Dekay evidently intended to question whether the species belonged to the genus *Fierasfer* and not whether it belonged to a species already named *Fierasfer borealis*. The correct identification of the species was not published till 1863 (*Proc. Acad. Nat. Sc. Phila.*, p. 332).

Peck's second species is the one now known as *Stromateus triacanthus* or *Poronotus triacanthus;* his third species is *Zoarces anguillaris*, and his *Cyprinus catostomus* is the *Catostomus commersonii*, the common sucker of Massachusetts.

III.

In 1817 the United States was visited by a Frenchman who is well entitled to be considered as the first ichthyological artist of his time—so far superior to all others, indeed, that there was no close second. I mean, of course, Charles Alexandre Lesueur, who was born in Havre on the New Year's day of 1778. He became the companion of François Peron in the notable expedition to southern lands which left Havre in 1800, under the command of Baudin, and was so fruitful of novelties for science. In 1815, he made arrangements with William Maclure by which he was enabled to visit the United States. After a prolonged voyage by way of the West Indies with Maclure, Lesueur arrived, May 10, 1816, at New York and there became acquainted with the statesman-ichthyologist Samuel Latham Mitchill. In the fall of the same year, he visited the coast and especially fishing towns of New England and the fish market at Boston. His collections afforded him a number of new species which he subsequently described in various articles in the *Journal of the Academy of Natural Sciences of Philadelphia.*

In 1817, he settled down in Philadelphia and at once became an intimate associate of the scientific men of that city, and his was the first article contributed to the first volume of the *Journal of the Academy of Natural Sciences*—that journal which has since extended into so many. It is in that series that were published a number of articles, illustrated by his unrivaled pencil. Thirteen specific names were framed for fishes obtained in Massachusetts, but most of them have not stood the test of time and comparison with more material. Lesueur remained at home in Philadelphia, more or less, till 1825. He then accompanied his old patron, Maclure, to New Harmony, Indiana, where they hoped to live an ideal life in a socialistic colony. It is almost needless to say that they were disappointed. While in New Harmony, Lesueur issued a prospectus for a work to be published in parts, by subscription, on the 'Fish of North America with plates drawn and coloured from nature.' The demand for the work was not sufficient to justify its publication and the project fell still-born. After various adventures and much sickness, he left, by way of New Orleans, for France, and after an absence of twenty-two years, was again at Havre in 1837. In Paris and in Havre he passed most of the remainder of his life and for the last two

years was director of the museum of the latter city. He died on the twelfth of December, 1846.

A very interesting biography of Lesueur by Dr. E. T. Hamy, a member of the Institute of France, appeared in 1904, entitled 'Les Voyages du Naturaliste Ch. Alexandre Lesueur dans l'Amerique du Nord (1815–1837).' It was published (1904) in the *Journal de la Société des Americanistes de Paris* (Vol. V.) as a special 'Numéro dédié par la Société a l'occasion de l'Exposition Universelle de Saint Louis.' It is illustrated by many landscape views reproduced from originals of Lesueur.

IV.

Next in order of time comes a work whose like was never seen in any other country and has never been equaled since. An expert in ichthyology, who should see it for the first time, without previous knowledge of it, might suppose that the author was an irresponsible idiot who had not intelligence enough to appreciate elementary facts. An ordinarily bad book might be left unnoticed, but the one in question is so abnormally bad as to be a curiosity of ichthyological literature, and interest and wonder must be excited at the variety of errors an educated man may be subjected to in a field of which he had no knowledge. Now hear who this man was and what positions of honor and profit were conferred on him.

Jerome Van Crowninshield Smith was born in Conway, N. H., July 20 (or 22), 1800, was graduated at the medical department of Brown College in 1818, and again at Berkshire Medical School in 1825 (or 1822). He became the first professor of anatomy and physiology in the latter institution. In 1825, he settled in Boston, was port physician from 1826 to 1849, and meanwhile was editor of several medical or other periodicals, among which were the *Boston Medical Intelligencer* (1823–1826), the *Boston Medical and Surgical Journal* (1834–1856), and the *Medical World* (1857–1859). In 1854, he was elected by the Native American, otherwise called the 'know-nothing' party, mayor of Boston, and served a single term (1854–5). Subsequently, he removed to New York where his son was resident, and was appointed to the professorship of anatomy and physiology in the New York Medical College. During the war of 1861–5, 'he went to New Orleans, where he accepted the position of acting inspector-general, with the rank of colonel, and he was the chairman of a commission appointed by Banks to consider the sanitary condition of the city.' He died at Richmond, Mass., in the residence of his sister-in-law, August 21, 1879.

His obituarist, in his old periodical, the *Boston Medical and Surgical Journal*, records that, 'although a man of no great ability, he could turn his hand to almost anything. For instance, it is said of him that, as a college boy, he was the champion drummer of his class. Later in life he was alternately anatomist, historian, naturalist, politician, a writer of books of travel, sculptor, editor and orator. He kept a whole set of the 'Encyclopædia Britannica,' on his office table and nearly every page was said to have a book-mark in it. He was a successful modeler in clay. Although a busy and active man, his practise was never a large one, but he nevertheless acquired considerable property'—testifying to another important talent!

Smith was a voluminous author and, besides numerous contributions to the periodicals he edited, published nearly a dozen independent volumes on various subjects. The only one of interest in the present connection is his 'Natural History of the Fishes of Massachusetts,' issued first in 1833, and again, as a 'second edition,' in

1843.* The second edition is a mere reissue, apparently, of the unsold remainder of the original, with a new title page and publisher's name. Even the original list of 'errata' is retained without any additions.

Now let us examine the work and we will find out what a strange production it was.

Smith's chief fountain of information was Mitchill's monograph, 'The Fishes of New York described and arranged,' published in 1815 in the *Transactions of the Literary and Philosophical Society of New York*.

He evidently had, as a standby, John Starks's 'Elements of Natural History,' published at Edinburgh in 1828, in which the classification proposed by Cuvier in the first edition of the 'Règne Animal' (1817), was followed. This served Smith as a guide for the arrangement of his material. Although the second edition of the 'Règne Animal' (1829) had been translated and published in New York a couple of years before (1831), it was unknown to Smith.

Another work he referred to as 'the Conversations Lexicon'; it was the 'Encyclopædia americana' of those days, which had then been very recently published.

For the illustrations, he had a work long ago forgotten, but which had a considerable circulation in its day; it was Strack's 'Naturgeschichte in Bildern mit erläuterndem

* Smith (Jerome Van Crowningshield). 'Natural History of the Fishes of Massachusetts, embracing a practical essay on angling.' By Jerome V. C. Smith, M.D. [Fig. of Falls.] Boston: Allen and Ticknor. 1833. [12mo, vii, 399 (+ 1) pp.]

—— The same with fifty-four wood engravings. By Jerome V. C. Smith, M.D. [Fig. of Menhaden.] Second Edition. Boston: William D. Ticknor. MDCCCXLIII. [12mo, vii + 399 (+ 1) pp.]

Its character was exposed in "Remarks on the 'Natural History of the Fishes of Massachusetts. * * *' Read before the Boston Society of Natural History, March 20, 1839. By D. Humphreys Storer, M.D. < *American Journal of Science and Arts* (Silliman's), Vol. XXXVI., July, 1839, pp. 337–349." According to Dr. Storer (p. 348), the work of his compatriot contains "notices of 105 species, of which 80 are foreigners, and but 25 are found in the waters of our State. Of these 105 species, 36 are illustrated by figures; of these 36 illustrations, but 9 accompany species which are found on our coast; of these 9 figures, 6 are copied from 'Strack's Plates,' and 3 from Mitchill's 'Fishes of New York'; of the 36 illustrations [small wood-cut figures] contained in this 'History,' not one is drawn from nature."

The other contributions of Smith to the ichthyology of Massachusetts are mere lists of names, viz:

——. 'A Catalogue of the Marine Fishes taken on the Atlantic Coast of Massachusetts. * * *' [Also, 'Fishes found in the Rivers, Mountain-Streams and Ponds of Massachusetts.'] > Report on the geology, mineralogy, botany and zoology of Massachusetts. By Edward Hitchcock. Boston, 1833, pp. 553–554.

A list of 52 nominal species of marine and 17 of fresh-water fishes.

There is discrepancy between the different biographical sketches of Smith as to name (Crowninshield or Crowningshield) and several dates. The article in Appleton's Dictionary of American biography is chiefly followed.

—— ['Revised Catalogue of the Fishes of Massachusetts.'] < *Op. cit.*, 1833, pp. 597–598.

A list of 102 nominal species, 83 of which (including the Bodiani = Morone) are salt- or brackish-water, and 19 fresh-water.

—— 'A Catalogue of the Marine and Fresh-Water Fishes of Massachusetts. < *Op. cit.*, second edition. Boston, 1835, pp. 534–538.

A list of the same character as the preceding, enumerating 106 nominal species (and 2 varieties), of which 89 are salt- or brackish-water, and 17 fresh-water. Reproduced (pp. 15–18) in the 'Catalogues of the Animals and Plants of Massachusetts' (edited by Edward Hitchcock), Amherst, 1835, reprinted (same type) from the second edition of the above-cited work.

The catalogue is a repetition of the names (without description or remarks) of the author's 'Natural History of the Fishes of Massachusetts.'

This compilation was also criticized (by Dr. D. H. Storer) in 1837 in "An Examination of the 'Catalogue of the Marine and Fresh-water Fishes of Massachusetts,' by J. V. C. Smith, M.D.," contained in Professor Hitchcock's 'Report on the Geology, Mineralogy, etc., of Massachusetts, by D. Humphreys Storer, M.D.' < *Boston Journal of Natural History*, Vol. I., pp. 347–365, pl. VIII. (May, 1836).

Text'; of the fish part two editions had been published at Düsseldorf, one in 1819–26 and the other in 1828–34. This work was the source of most of the reduced and very poorly engraved wood-cuts which accompany the text; three were borrowed from Mitchill's 'Fishes of New York.' Such are the facts, but in his preface Smith makes no mention of Strack's work and leads up to the supposition that his cuts were original. His words are, "With respect to the engravings, they are far short, in many instances, of what was anticipated. Some of them are beautifully and accurately executed; but others are miserable caricatures. The artist was young and inexperienced, and when he would have willingly made a second drawing the press could not be kept in waiting."

He has certainly told the truth in the acknowledgment that the engravings were 'miserable caricatures.' They are generally very poor copies of the originals. For example, Strack's figure of the fresh water lamprey represented correctly seven lateral branchial foramina; Smith's copy only five! A few examples may now be examined as samples of the many kinds of errors he committed. To expose all would require a volume as large as the one noticed.

Under the caption 'GEN. SCYLLIAM' three species are claimed for Massachusetts, the 'sea-dog, *Scyllium Canicula*' (p. 80); the '*Scyllium Catulus*' (p. 81); and the 'dog-fish, *Squalus Canis*' (p. 82). Now, no species of the genus *Scyllium* has ever been obtained from the coast-waters of Massachusetts and the only sharks called sea-dog or dog-fish that could have been known to Smith were the picked dog-fish, *Squalus acanthias*, and the smooth hound, *Mustelus canis*, which were not named by him.

Gray mullets or mugilids, as every one here knows, are among the most common of the shore fishes from Woods Hole southward, and, under the name *Mugil albula*, were well described by Mitchill in 1814, in New York, but Smith urges (p. 268), 'Notwithstanding the minute description there given, we think there must be some mistake, and our private opinion is that no other species than the red mullet is a native fish'! Following up this fancy, under the caption 'GEN. SARMULLUS' (a new name!) he specifies (p. 271) the 'red mullet, *Mullus Barbatus*,' and, after a break of many pages, immediately after the mackerel (p. 304), he names 'the surmullet, *Mullus Surmuletus*.' As to the former, he avers (p. 271) that 'red mullet have appeared, within the last few years, in the neighborhood of Boston, but not being at all prized, a few only have been exhibited in the market.' The surmullet was declared (p. 304) to be 'a variety of the mackerel,' and this remark was followed by comments on its place in Roman estimation, on what was evidently the chub mackerel, and on fishing for mackerel!

There is a peculiar genus of gadoidean fishes named *Raniceps*, represented by a single species of northern Europe, and the type of a distinct family, Ranicipitidæ. To this 'GEN. RANICEPS' Smith referred two species; one named (p. 209) 'Blenny, *Blennius Viviparus* [*Raniceps Trifurcatus, Cuv.*],' the other (p. 211) '*Raniceps Blennioides*.' The former was evidently the *Zoarces anguillaris* and consequently belongs to a widely different species from the '*viviparus*,' a different family from *Blennius*, and a different family also from *Raniceps trifurcatus*. The latter name, we learn from Storer, represented a specimen 'purchased of' Smith, by the Boston Society of Natural History, of a *Cryptacanthodes maculatus* 'with *the cuticle* abraded'; consequently the species belongs to a very distinct family from the genus *Raniceps*, as well as from the first species.

Another striking manifestation of his

ignorance and rashness is displayed in the treatment of a couple of other species. Under the 'Gen. Cobitis' (p. 183) he notices the 'sucker, *Cyprinus Teres* [*Catastomus*].' In the third paragraph under the specific caption he refers to 'a strange fish' given by the keeper of the Boston Lighthouse, unknown "to any of the fishermen in his service, which has a mouth precisely like the fish above described; but the body, instead of being round, is quite thin [!] and wide, back of the gills. The color is silvery, mottled with dark waving lines. It is in length about ten inches, and appropriately denominated the *sea-sucker.*" What could this 'sea-sucker' have been? One familiar with the fishes of the coast and with Smith's idiosyncrasy might reconcile the notice with the king-fish (*Menticirrus nebulosus*), but the sucker is a malacopterygian and the king-fish an acanthopterygian, and, besides, the latter has a mouth not at all like that of a sucker in reality! All this is quite true, but on an examination of the very specimen mentioned by Smith, it was found by Storer to be a king-fish.

How Smith was led to put the sucker in the genus *Cobitis* and to separate it from its near relation, the chub sucker, *Erimyzon sucetta,* which was placed in the genus *Cyprinus* as the 'chub, *Cyprinus oblongus,*' is not at all comprehensible.

The habit of assuming that the popular names were correctly applied led to other curious results. Some of the most abundant of the fishes of the state are the cyprinodonts known as minnows and the sun-fish, called also bream and roach. The cyprinodonts and sun-fish do not appear at all in their proper persons in the 'Natural History'; the only mention of any minnow is under the head of 'minnow, *Cyprinus atronasus*'; the names of 'bream, *Abramis chrysoptera,*' 'roach, *Leuciscus rutilus,*' and 'dace, or dare, *Leucisus vulgaris,*' are found, but only in connection with the European fishes, which, it scarcely need be added, are not American fishes.

Still another kind of error is found in statements respecting distribution. As we all know, the shad was introduced into the waters of the Pacific slope by the United States Fish Commission because it was supposed none were there. According to Smith, however, 'on the northwest coast of America, they are inconceivably numerous'!

The examples thus given are quite enough to illustrate some of the kinds of errors Smith fell into.

The only item of new or special interest found in the entire volume is not from the pen of Smith, but of a correspondent, Jas. P. Couthuoy, captain of a merchant vessel, who later became known as an able conchologist and accompanied Captain Wilkes in his celebrated voyage around the world. In a postscript to a general letter, published in the article on the mackerel, Couthuoy added, 'though you are already, perhaps, aware of it, * * * the male dolphin may be easily distinguished from the female in the water, by the shape of the head; that of the former being abrupt, and almost perpendicular, * * * while the female's is more rounded.' This statement, written in January, 1832, and published in 1833, anticipated by five years the discovery of M. Dussumier, announced in the 'avertissement' (p. vii) to the twelfth volume of Cuvier and Valenciennes' 'Histoire Naturelle des Poissons' (1837). In view of our knowledge of Smith's character, the suggestion that he was aware of such a fact sounds quite ironical. No ichthyologist has recognized the claim of Couthuoy to the discovery in question.

Smith's wretched book misled many of the anglers of the middle of the past century; frequent evidences are to be found of his influence in the principal works

(Brown's 'American Angler's Guide' and Herbert's 'Frank Forrester's Fish and Fishing of the United States') which served as guides to the fishermen of that time; even so able an ichthyologist as Sir John Richardson quoted it and was evidently much puzzled by it.

V.

The next author whose work demands examination was a man of quite a different character from Smith, and who, for nearly three decades, published the results of studies of the fishes of Massachusetts. His last work is still the most comprehensive illustrated volume descriptive of the fishes of Massachusetts alone.

David Humphreys Storer was born in Portland, Maine, March 26, 1804, attended Bowdoin College and was graduated there in 1822, then studied medicine, and was graduated from the medical department of Harvard College in 1825. Immediately afterwards he established himself in Boston as a general practitioner of medicine. "In 1837 he cooperated in founding the Tremont Street Medical School. He became interested in natural history in 1831 and was one of the founders of the Boston Society of Natural History," and in 1838 was elected curator of the herpetological and ichthyological collections. He was also 'commissioned' in 1837 as one of the commissioners to report on the zoology and botany of Massachusetts under an act of the legislature 'approved 12th April, 1837.'

In 1854 he was called to the professorship of obstetrics and medical jurisprudence in the medical school of Harvard; in 1859 became also the dean, and held both appointments till 1868. Meanwhile, from 1849 till 1858, he was physician to the Massachusetts General Hospital. In 1866 he served as president of the American Medical Association. He was honored by Bowdoin College in 1876 with the degree of LL.D. In 1883 he retired almost entirely from practise and spent the remaining years of his life in the enjoyment of well-merited leisure.

His principal works relative to the region under consideration are 'A Report on the Fishes of Massachusetts,' published in the *Boston Journal of Natural History*, in 1839, and 'A History of the Fishes of Massachusetts,' published in the *Memoirs of the American Academy of Arts and Sciences*, from 1853 to 1867.* These were

* Storer (David Humphreys). 'A Report on the Fishes of Massachusetts.' By D. Humphreys Storer, M.D. < *Boston Journal of Natural History*, Vol. II., 1839, pp. 289–558, pl. VI.–VIII.

Descriptions are given of 107 nominal species, 91 of which are salt- or brackish-water, and 16 fresh-water; in the concluding remarks, 9 additional undeterminate species are indicated as probable inhabitants of the Massachusetts waters.

—— 'Supplement to the Ichthyological Report.' < *Ib.*, Vol. III., 1841, pp. 267–273.

—— 'Additional Descriptions of, and Observations on, the Fishes of Massachusetts.' 1842. < *Ib.*, IV., 1844, pp. 175–190.

A second supplement to the report.

—— 'Reports on the Ichthyology and Herpetology of Massachusetts.' By D. Humphreys Storer, M.D. < Reports on the fishes, reptiles and birds of Massachusetts. Published agreeably to an order of the legislature, by the commissioners on the zoological and botanical survey of the state. Boston: Dutton & Wentworth State Printers, 1839. [8vo, xii [+ 2 l.], 426 pp., 4 pl.], pp. 1–253, with half-title,—Fishes of Massachusetts,—pp. 1–202, pl. 1–3.

The report on the fishes is the same as that published in the *Boston Journal of Natural History*, but (1) an entirely different introduction is added, (2) the supplementary observations on '*Carcharias obscurus*' (*B. J.*, III., 558) are omitted and (3) supplementary observations are added (pp. 405–409) on several species.

The plates are apparently printed from the same lithographic stones.

—— 'A Synopsis of the Fishes of North America.' < *Memoirs of the American Academy of Arts and Sciences*. New series. Vol. II. (Cambridge, 1846), pp. 253–550.

739 nominal species from all North America (including the West Indies) are described. The

later published as separate works and with independent pagination, and doubtless are in such form constantly referred to at Woods Hole, as they are still the largest complete works that refer avowedly to the region in question.

The report of 1839 was a useful compilation of existing knowledge respecting the subject-matter, and for the first time brought together descriptions which could only have been found previously in scattered publications. The classification of Cuvier, then almost universally accepted, was adopted.

William Yarrell, the author of 'A History of British Fishes,' not long before published (1836), was an exemplar for the report, and as Storer acknowledges, 'the generic characters are generally given in the language of Yarrell.' The genera not represented in Britain are defined after the same pattern.

'For many years,' according to his obituarian biographer, 'it was the standard work on our fishes and was only supplanted in New England esteem by the revised, extended and fully illustrated work completed in 1867.'

The history is really an amplified edition of the report with some of the species that had been discovered in the meanwhile incorporated and with plates illustrating all the species described in it but one—the so-called *Blennius subbifurcatus*, which is a typical Stichæid.

Storer claims to have 'carefully redescribed all the species' for his history, and it has been declared by an eulogist that 'it would be difficult to point out a work of greater accuracy in detail.' Consequently it has been proclaimed to be 'a classic in North American ichthyology that must serve as a basis for the future histories of the New England fishes.' Naturally such a work calls for examination. If some discrepancy shall be found to exist between the estimate of the eulogist and that now to be presented, it must be remembered that the former was hampered by the demands of a memorial celebration, while, on the present occasion, only the facts need be considered.

In the sixth decade of the past century, the classification proposed for the fishes by Cuvier, in 1829, in the second edition of the 'Régne Animal,' was still regnant. Naturally, then, Storer adopted it for his 'History' as he had previously for his 'Report.' He added diagnoses of the families which were in almost all cases translations of the essential characteristics assigned to them by Cuvier. In the au-

descriptions, however, are mostly inaptly compiled and insufficient.

—— 'A Synopsis of the Fishes of North America.' By David Humphreys Storer, M.D., A.A.S. Cambridge: Metcalf and Company, printers to the university. 1846. [4to, 1 p. l. (=title), 298 pp.]

A reprint, with separate pagination, title-page and index, of the preceding.

—— 'A History of the Fishes of Massachusetts.' By David Humphreys Storer. < *Memoirs of the American Academy of Arts and Sciences* (Boston), new series, viz:

1. V., pp. 49–92, pl. 1–8, 1853.
2. V., pp. 122–168, pl. 9–16, 1853.
3. V., pp. 257–296, pl. 17–23, 1855.
4. VI., pp. 309–372, pl. 24–29, 1858.
5. VIII., pp. 389–434, pl. 30–35, 1863.
6. IX., pp. 217–263, pl. 36–39, 1867.

134 species are described and (except one—the *Pholis subbifurcatus* = *Eumesogrammus subbifurcatus*) *illustrated*, and, in an appendix, a nominal list (by Mr. Frederick Putnam, of Salem) of 21 additional species is published. Of the 134 species, 116 are salt- or brackish-water, and 18 fresh-water.

—— A History of the Fishes of Massachusetts. By David Humphreys Storer, M.D., A.A.S. * * * (Reprinted from the Memoirs of the American Academy of Arts and Sciences.)—Cambridge and Boston: Welch & Bigelow and Dakin & Metcalf. 1867.

As indicated on the title-page, a reprint of the preceding, or rather a collection of extras of the several parts separately and consecutively paged, and with an independent title-page and index.

thor's nomenclature, he was "guided as far as possible by the principle which would give the credit of a species to the author who first placed it under its appropriate genus. This plan," he truly added, he "was led to understand is being adopted by our most eminent naturalists." For a time such was the case.

The work was and is of such importance that some analysis may be welcome.

As long as the writer had a guide to follow, his faults of taxonomy were mainly those of his guides, but he had the fortune, good or bad, to obtain specimens of types unknown to the authors whose views he followed, and then he had to determine their affinities as best he might. The result by no means did credit to his perspicacity. Among these types were the genera *Boleosoma* and *Cryptacanthodes*.

Boleosoma had been quite correctly referred by Dekay to the family of Percidæ, and is in fact a perch in miniature. Yet Storer referred it to the 'Triglidæ,' between *Acanthocottus* and *Aspidophoroides*, in spite of the fact that he declared (after Cuvier) that 'their general character consists in having the suborbital bone more or less extended over the cheek and articulated behind with the preoperculum.' Why he should have referred to such a family a genus with the suborbitals reduced to such an extent that they had been said to be absent is a mystery which he made no attempt to explain.

Cryptacanthodes was first named by Storer in 1839. It is an elongated naked fish without any enlarged suborbital bones and entirely unlike any recognized triglid. On the other hand, it has many characters in common with genera of the family of 'Gobidæ' (as he called it), and in accordance with his own definition he should have referred it to that family. In fact, the genus is the type of a peculiar family nearly related to that of the gunnells.

The same ineptitude for the appreciation of characters or form is manifest in the treatment of species which he actually referred to the family 'Gobidæ.' To the genus *Blennius* was relegated a species named *Blennius serpentinus*, and to the very closely related genus *Pholis* was assigned another species named *Pholis subbifurcatus*. Now, the true species of *Blennius* and *Pholis* have a very characteristic physiognomy, and only differ from each other in the fact that the former has skinny tufts over the eyes which are wanting in the latter. Yet the *Blennius serpentinus* has a very elongated form and no superciliary tufts and the *Pholis subbifurcatus* has also an elongated form and, therefore, no resemblance to a true *Pholis*. In fact, the two species belong to a different family from *Blennius* and *Pholis* and are related to each other. They are the stichæids now named *Leptoblennius serpentinus* and *Eumesogrammus subbifurcatus*.

The want of appreciation of the value of words as well as of natural relations was also manifested in the treatment of the flat-fishes. Cuvier had divided the typical pleuronectids into three genera or, as he called them, subgenera: *Platessa*, distinguished by a row of obtuse trenchant teeth on the jaws; *Hippoglossus*, having strong pointed teeth, and *Rhombus*, including the turbots. While professedly adopting these genera, he referred to *Platessa* several species (*dentata, oblonga, quadrocellata*) which are really more nearly allied to the halibut and European species associated with that fish. Cuvier had not referred to the American species and Storer had consequently to do for himself.

The last genus that requires attention is *Carcharias*. The part of the 'History' referring to it was published in 1867. As early as 1841 Müller and Henle had published their great work on plagiostomes and the sharks of the American coasts had

long been referred to their proper genera. But all the labor was lost, so far as Storer was concerned. Four species were referred by him to the genus. Only one (*obscurus*) has the characters assigned in the diagnosis. One (*griseus*) is an *Odontaspis*, another (*vulpes*) an *Alopias*, and the fourth (*atwoodi*) is the great white shark (*Carcharodon carcharias*). It will be thus seen that his four species of *Carcharias* belong to four families of Müller and Henle and most modern systematists.

If we examine his descriptions we too often find that while they fill every requisite as to length, there is too much perfunctory verbiage and too little precision. For example, the 'form' of the striped bass as well as of the common mackerel is said to be 'cylindrical,' while the Spanish mackerel (*Scomber dekayi* or *colias*) is claimed to have the 'body elongated.' Now, there is really no difference in form between the two mackerels and that form is as nearly fusiform as any fish can have. Any one who knows what a cylinder is would be so misled by the use of the word that he would be precluded from identifying the striped bass from the description, if he relied on it. The mackerels are certainly elongated, but so is an eel and so also is a hairtail; it is evident, therefore, that the unqualified adjective is altogether too vague and meaningless. These examples of the want of precision and misuse of terms must suffice.

Another feature which may excite the surprise of the new student is the meagreness of the information respecting habits of species. There are some statistical data concerning the mackerel, herring and cod, some observations on the habits of the sunfish, toad-fish and trout and briefer references to others, but the parental care exercised by the sticklebacks and catfishes and the peculiarities of others, are not even alluded to. Comparatvely little was known in those days of such matters, it is true, but information about the characteristics in question was already existent in the literature.

The best part of the work is the collection of plates. These are really for the most part excellent and among the best that have ever been published. Most of them were prepared by A. Sonrel, who had been trained for such work by Agassiz. But the want of supervision was occasionally evident even here. For example, adopting the fashion then prevalent, scales from the back and lateral line were illustrated for almost every scaly fish. Now, the most characteristic feature of the scales of the sparoid fishes is the divergence of the striæ across the field above and below and their intersection of the margins. Sonrel had represented the fine concentric striæ of the scales of the early families correctly, but, in place of well-marked striæ for the sparids, he gave meaningless dots (pl. 10, f. 2, 3, 5, 6); apparently he had perceived something anomalous to him in the sparoid scales, but was afraid to represent what he saw and adopted the device of obscurity and ambiguity expressed in punctulation.

Another case of bad iconography was exhibited in the figure of the so-called *Blennius serpentinus* (pl. 17, f. 1.) Storer conceived for this fish a very deeply divided dorsal whose parts were 'connected by a membrane' (p. 91). Probably the fin had been injured; in a perfect specimen the fin is uninterrupted. The artist may have been influenced by the ichthyologist; possibly the ichthyologist may have been misled by the artist; anyway, the representation of the fin accords with the description and not with nature.

It will be evident that all the criticisms that have been passed on the 'History' are those that might have been made at the time the parts were published. In the allocation of some of the genera and species

he sinned against his own definitions. His nomenclature has not been considered as such and need not be. Respecting that, hear what his obituary biographer had to say.

In the words of that eulogist, "in the time that has passed since its publication we have changed our ideals of names, and discoveries of new genera or species, or in the anatomy, have compelled changes in our system. The nomenclature of the book has become somewhat antiquated, and the systematic arrangement is not entirely suited to the present time."

His eulogist has further truly remarked that Dr. Storer 'used little of his energy in searching for generalizations.' In fact, the only evidences he has left of any attempts at generalization were a simple table of the geographical distribution of genera of North American fishes and the isolation of the genus *Amblyopsis* in a family he called 'Hypsæidæ.'* We may pass them without comment save that they were laudable attempts at least.

I have alluded to these defects of Storer's work because for a long time they influenced our conceptions respecting the fishes of the coast and were generally adopted. The errors were repeated by Dekay in 1842 and (pardon the expression of personal experience) the discrepancy between the facts and the print sadly perplexed my boyish studies and for a time made me fear that failure to understand was the fault of my stupidity rather than Storer's and Dekay's fault. In fact, they remained uncorrected till I had to demonstrate that the statements were inconsistent with the facts and formulated the views now prevalent.

VI.

In 1872 was published an article which would not call for notice, since it is devoted to a limited locality and covers a very short period, were it not that the locality is very near Woods Hole and that it emanated from such distinguished ichthyologists as Dr. Franz Steindachner and Professor Agassiz, under the editorship of Col. Theodore Lyman. The article is a catalogue of the 'Fishes taken in the Waquoit weir, April 18 to June 18, 1871,' and was published in the 'Sixth Annual Report of the Commissioners of Inland Fisheries' (pp. 41–58, pl. 1–2). We are told that 'most of the nomenclature is by Dr. Franz Steindachner; and some notes by Professor Agassiz are added marked A.' Only forty-four species were obtained. The nomenclature for the most part is that prevalent during the previous half century and not that which had been in general use for the preceding decade and is prevalent now. Some interesting statistical and biological data are given. No species previously unknown to the state or region in question were added.

This was the last authoritative faunal contribution of Massachusetts naturalists. The labors of the excellent ichthyologists of the state, chief of whom, for many years, has been S. E. Garman, have been with excellent judgment devoted to the elucidation of questions of morphology and taxonomy. The greater facilities enjoyed by the United States Fish Commission have been recognized and the task of formal registration has been left to those directly or indirectly connected with that organization.

VII.

Before Storer's 'History,' was completed and before the Waquoit weir was examined, Professor Spencer F. Baird visited Woods Hole and spent part of several summers there with his family. His first visit was made in 1863: he then found forty-seven species and among them, for the first time, the very young of *Trachynotus carolinus* and *T. ovatus*

* Syn. Fishes N. A., pp. 4–8; 183, 184, 1846.

(*falcatus*). These as well as *Cyprinodon variegatus* were recorded by Gill in the *Proceedings of the Academy of Natural Sciences* for 1863 (p. 322) and later, with other material, served as the basis for the reduction of three genera of earlier American ichthyologists to one species and of the generalization respecting the mode of development and growth of the carangids and scombroideans generally.

The United States Fish Commission was established in 1871 and the village that the commissioner had proved as a private was selected by the officer as a station of the new commission. With government means for exploration, many species previously unknown to the coast were added, and up to 1873 not less than twenty-three species new to the region were found, exclusive of those already referred to. These were enumerated in a 'List of the Fishes collected at Wood's Hole, by S. F. Baird,' published in the 'Report of the United States Commission of Fish and Fisheries' for 1871–2 (pp. 823–827). The list was one of names (scientific and popular) only, arranged in accordance with Gill's 'Catalogue of the Fishes of the eastern coast of North America' printed just in advance of it.

Conspicuous publishers of an enumeration of Massachusetts fishes were G. Brown Goode and Tarleton H. Bean, connected with the United States Fish Commission. Under the form of 'A Catalogue of the Fishes of Essex County, Massachusetts, including the Fauna of Massachusetts Bay and the Contiguous Waters,' they gave the names of all the species known from the state; 'it is believed to be complete to the date of publication.' The catalogue was published in 1879 in the *Bulletin of the Essex Institute* (XI., pp. 1–38). The sum total listed amounted to '183 species, of which 163 inhabit salt or brackish water, 20 fresh water.' The 'number of marine species from within the limits of Massachusetts Bay * * * is 133; while 29 are from the deeper off-shore waters in the vicinity of Georges, Le Have, Browns and Sable Island Banks.'

Only twenty of the species have exactly the same names as were adopted by Storer.

As just indicated, a number of the species enumerated by Goode and Bean have never been found except in deep off-shore waters, and consequently not within the limits of the state, or even very near it. There are twenty-four such and they should be excluded from the fauna of the state. The ejected species are deep-sea or pelagic forms which are more foreign to the real fauna of Massachusetts than are the fishes of Florida or of Britain.

The catalogue of Goode and Bean, on the whole, is a well-considered and valuable memoir, brought up to the date of its publication.

VIII.

The last census of the fishes of Massachusetts relates to a part of the coast, but that the most important from an ichthyological point of view at least; it is a catalogue of 'The Fishes Found in the Vicinity of Woods Hole by Dr. Hugh M. Smith, Chief of the Division of Scientific Inquiry, U. S. Fish Commission,' now deputy commissioner. It was published in advance and appears in the 'Bulletin of the United States Fish Commission' for 1897 (XVII., pp. 85–111, with folded map); it was supplemented in two later volumes (XIX., 309–310; XXI., 32). These give a most useful summary of the fishes of the region indicated, enriched with notes respecting occurrence, comparative rarity or abundance, and time of appearance. The species are arranged in the sequence adopted by Jordan and Evermann, and their nomenclature is also accepted. The number of species recorded in the main list was 209; in 1899, 16; and in 1900, 4. The present

number of fishes recorded up to date is 229 marine species, and if to these we add 11 fresh-water ones occurring in the vicinity, we have no less than 240. It is remarkable that at so late a day so many species previously unknown to the coast should have been found. Dr. Smith, in his main article, enumerated 23 such species; in 1899, added 16, and in 1900, 4 more. No additional ones have been discovered since—a fact by no means surprising. The additional species, with one exception, were known estrays from tropical waters; the exception was supposed to have been previously unknown and was described as *Chætodon bricei*.

If we now first subtract from Goode and Bean's 'Catalogue of the Fishes of Essex County' 24 species which are deep-sea forms not yet found in Massachusetts Bay, we shall have left 36 species which have not been found about Woods Hole. These, added to the 240 actually found there, and 5 more from fresh water will give us a total of 281, the number of species now known to have been found some time or other along the coast of Massachusetts or in her interior waters.

IX.

A specially notable feature in the late enumerations and additions to the fauna of southern Massachusetts is the great number of young tropical fishes and the comparative or total absence of adults. Sixteen species were added in 1899 to the piscine visitors to Woods Hole and four in 1900, and of these no less than eighteen were the young of typical tropical forms. In round numbers, about three dozen species of tropical fishes have been found along the coast, represented only or almost only by the young—often the very young. In olden times, when persons believed, or thought they believed, that all fishes laid eggs at the bottom, it would naturally have been inferred that such young must have been hatched close by, and that the parent fishes had spawned in the northern seas. Such an inference, with our present knowledge, is quite unjustifiable. We now know that a very large proportion of fishes develop pelagic or floating eggs and not demersal ones. If such fishes, then, would discharge their ripened ovarian burdens near the surface of the open sea where currents would carry them northward, many of the young in time would be drifted into high latitudes. Not a few of these involuntary travelers, by fall time, might reach the latitude of Woods Hole or near it, and winds blowing shoreward might account for their presence along the coast. We know that the parent fishes live close to the gulf stream in southern Florida and you know that masses of gulf weed are frequently drifted on the nearby coast and that such was especially the case in the year when the young tropical fishes were found in such numbers along the coast. It would be interesting to follow the long voyages of such travelers.

Here, then, is a field which the fish commission and the laboratories at the Tortugas and Beaufort might investigate. The towing-net is as necessary a tool for the biologist as the dredge, and surface-collecting, though it may not yield as many new species, will add more to our knowledge of the life-histories of many common animals than dredging. While grateful for all these agencies, and especially the United States Fish Commission, for what has been done, let the past be the presage of a still more active and fruitful future. May American enterprise rival the patriotic efforts of Danish sailing-masters and gather materials which shall compare with those which Christian Lütken used so well, long ago, in the elucidation of pelagic fishes. As to the special Piscifauna of Massachusetts, a future task will be to subtract rather

than to add. A problem to determine must be what shall be considered as fishes really belonging to the fauna. Certainly inhabitants of the deep seas, which never approach the territorial limits of a state, can not properly be considered as members of the fauna. Such types as the chimærids, simenchelyids, nemichthyids, saccopharyngids, alepocephalids and macruids are characteristic constituents of the deep-sea or bassalian realm. The involuntary estrays from tropical seas, whose lives are terminated with the increasing cold of the fall and winter months, also cannot claim to be reckoned as constituents of the fauna. They are representative of a very distinct realm—the Tropicalian. They do, however, furnish very useful hints for the determination of zoogeographical problems. We have the evidence that in times past a few estrays from tropical families have established homes far from those of their kindred. All such problems and considerations, however, must now be left for the future and for other hands.

THEO. GILL.

SMITHSONIAN INSTITUTION.

THE COLD-CURRENT SYSTEM OF THE PACIFIC, AND SOURCE OF THE PACIFIC COAST CURRENT.

I PROPOSE to offer reasons for believing that an immense system of currents of ice-cold water occupies a large part of the Pacific Ocean, corresponding in magnitude to the vast warm-current system of the equatorial Pacific, which culminates in the great Gulf Stream of Japan, or the Kuro Siwo.

But preliminary to this I would note some points relative to that remarkable stream of cold water, which flows in a vast volume southerly, skirting southeast Alaska, Vancouver's Island, the Pacific states of Washington, Oregon and California, and finally passes out westward to Hawaii, beyond which group it becomes merged into the great equatorial current running westward.

This stream is of very low temperature, of immense volume and of great velocity. It is unique in its powerful effects upon the climates of the coasts along which it flows. To the states of Washington and Oregon throughout the summer it imparts a constantly cool and moist climate extending over one hundred miles into the interior. It also greatly mitigates the cold of winter. Both these conditions are in strong contrast to the arid summer and biting winter climates which prevail in the interior of those states east of the Cascade Range.

To the entire coast of California from Klamath to Los Angeles this current lends chill fogs throughout the summer afternoons, whose moisture clothes with verdure the coast hills for many miles in breadth, while the interior of the state is dry and parched. It makes warm clothing needful in San Francisco every day in the year. It also mitigates the scorching heats of the interior valleys of California, giving cool nights to render them habitable.

Finally turning westward like the trade winds under the impulse of the globe's rotation, this mighty current broadens out into the open ocean, gradually gaining warmth. After traversing 2,200 miles it reaches the Hawaiian Islands, still at the low temperature of 70° in late summer, and of below 60° in late winter. This imparts to that favored group a uniformly subtropical climate such as is unknown to any other land in the same latitude. Borne on this powerful current there may often be seen passing the islands or landing on their shores, immense trees as well as saw-logs which have been swept to sea by freshets in the Columbia River.

What is the source of this mighty current? This is a problem not hitherto solved. It has been the custom to call it a

continuation of the great Gulf Stream of Japan or Kuro Siwo. To that solution of the problem there are two objections which appear insuperable.

One is that the Japan stream must necessarily pass out and dissipate itself in the vast breadth of the Pacific Ocean long before reaching Alaska. Even if enough of the Kuro Siwo could hold together to form a noticeable current on the Alaskan coast, it could be only a wasted and meager stream, wholly unlike the mighty current that skirts the continent.

The other objection is the extreme coldness of the American coast-current. This could not possibly proceed from water of such high temperature as the Kuro Siwo, if the latter had held together as a compact stream. So compacted, it must have retained most of its warmth, even in traversing the higher latitudes. It has been alleged that it has been chilled by passing the vicinity of the great Alaskan glaciers. But the Muir glacier, the Malaspina and all combined are of comparatively limited extent. They send no bergs out to sea; they are totally inadequate materially to cool the adjacent ocean.

What then is the real source of the Pacific coast cold current? Leaving for a little this problem, turn we now to a second one, which may help us to find the answer to the first. The depths of the Pacific Ocean are occupied throughout by an immense stratum of ice-cold water at 35°, which is slowly creeping northward. The existence of this cold stratum is well established by all deep-sea temperature soundings throughout the Pacific. That it is creeping northward is inferred from an analogous condition under the Atlantic Ocean. It is a fact familiar to hydrographers that a similar stratum of cold water underlies the Atlantic at a depth of 2,000 fathoms. Near the equator, however, the 35° stratum is found to rise to within a few hundred fathoms of the surface. The necessary inference is that two opposite currents are meeting and pushing each other upwards, the one derived from the Arctic ice, the other from the Antarctic. Nearing the surface they gather warmth and commingle with the warm equatorial current running westward.

But in the Pacific Ocean, while the depths are at the same 35° as in the Atlantic, there is no rising of the cold water at the equator. The reason is evident. The supply of cold is confined wholly to the Antarctic ice. The Pacific is closed at the north, and the Arctic ice exerts no influence on its waters. There is no northern deep-sea current to meet and push up the southern one at the equator, and the latter creeps on unobstructed to the northern bound of the ocean.

This southern current is evidently of great magnitude. It proceeds from a Pacific frontage of the vast Antarctic continental glacier extending 4,000 miles in length along the Antarctic Circle. The ocean waters from the north encountering this massive ice-front and its bergs are chilled and sink to the bottom. Thence they creep north in a wide and deep stratum underlying the whole breadth of the Pacific. Reinforced and pushed on by constantly chilled supplies behind, they press on up the whole 8,000 miles' length of the ocean, encountering no adverse current from the Arctic Circle.

Here comes our second problem. Where does this vast creep of cold water find outlet? Somewhere it must escape to the surface. Where does it emerge to unite with the upper ocean? Before indicating the answer to this second problem, we may note two conditions encountered by this vast creep of water, which may assist in guiding us to the answer.

The first condition is that after passing the Tropic of Cancer, the Pacific Ocean

rapidly contracts in breadth. In latitude 45°, it is only half as wide as at the equator. The consequence is that the northward-moving waters are accelerated to twice their previous velocity.

The second condition is that in reaching a higher latitude this accelerated current becomes subjected to a powerful eastward thrust from the rotation of the globe. As its distance from the earth's axis diminishes in going north, its retention of the more rapid eastward rotation acquired at the southward must drive this current with great force to the east. The inevitable result must be that the whole body of cold water going north is driven powerfully against the shores of the North American continent in the latitudes of Sitka and Vancouver's Island. This is illustrated in the accompanying diagram.

Here then we have two problems, both relating to cold currents. The one concerns the source of the mighty Pacific coast current, the other relates to the final outflow of the deep-sea cold stratum. It is obvious that the two problems fit and solve each other. The answer to both becomes plain. The source of the coast current is in the deep-sea stratum. The outflow of the deep current is the great coast-current. Each fits the other. Together they constitute one system.

The deep-sea current driven by the globe's easterly thrust, and encountering the shoaling ocean bottom, is crowded against the coast, forced to the surface, and driven southwards as its only possible outlet. And so emerges to being the great Pacific coast current.

Such then is the story of the great Cold-current system of the Pacific. And such is the source of the wonderful cold current of our Pacific coast. It is generated by the massive continental glacier which skirts the Antarctic Circle. It slumbers long in the sluggish womb of the dark Pacific depths. It quickens to activity in the narrowing northern ocean. Finally stung to life by the rotary thrust of the globe, it springs to birth as the mighty current sweeping along the western shores of our continent, dispensing coolness and moisture to populous states. And finally it bestows coolness and calm and exemption from tempests to the islands, making a genial paradise of the otherwise sultry Hawaii. All those favored shores derive their genial climes from the transmitted coolness of the Antarctic ice.

I propound this as a most probable theory of a current system hitherto undivined. It remains to verify it by systematic soundings and determination of limits of the coast-current.

S. E. Bishop.

Honolulu, T. H.,
February, 1904.

NOTE.—Since the foregoing article was sent for publication, an important element is found to have been overlooked. This is the effect upon the coast current of the powerful westward thrust of globe-rotation, corresponding to that which causes the trade-winds and the equatorial currents. This thrust must begin to act with great power as soon as the coast current begins to move to the southward. Such thrust must absolutely forbid that great current to cling as it does to the coast from Alaska to southern California, unless some other force intervenes. This fact, therefore, constitutes an *absolute proof* that the source of the Pacific coast current is not from the Kuro Siwo, because as soon as that current should turn southward, it must at once be pushed by the globe rotation westward into the open ocean.

But this element of force proves much more. The fact that the coast current does actually move eastward of south, clinging to the eastward trend of the coast in opposition to the westward thrust to which it is subjected, demonstrates the presence all along its course of a very mighty source of eastward pressure. That source can be no other than the broad and massive current from the Antarctic pushing up from the deep sea under the easterly globe-thrust along the entire coast from Alaska to Los Angeles. As soon as that confining pressure is removed, the coast current turns westward, finally to unite with the equatorial current in the tropics.

I seem, therefore, to have the right to claim an absolute certainty for the theory that a cold current from the deep sea impinges against the American Pacific coast from Alaska to southern California. The vast body of cold water actually appearing there can by no possibility have moved from a northern source to the *eastward* of south, such direction being forbidden by the rotation of the globe. S. E. BISHOP.

MEMBERSHIP IN THE AMERICAN ASSOCIATION.

THE following persons have completed membership in the association since April 1, 1904:

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Angle, Dr. Edward H., 1023 North Grand Ave., St. Louis, Mo. (53.) F.

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SCIENTIFIC BOOKS.

Sir William Henry Flower, K.C.B., F.R.S., LL.D., D.C.L., Late Director of the Natural History Museum, and President of the Royal Zoological Society. A Personal Memoir by Charles J. Cornish, M.A., F.Z.S. London, Macmillan and Co., Limited; New York, The Macmillan Company. 1904.

In reading this memoir of Sir William Flower we feel that his was preeminently a life of action, and we are impressed with his achievements rather than with his character. Not that Mr. Cornish has neglected this part of his work; in fact, the author seems to think that some might consider the personal element too pronounced, but that Flower accomplished so much. Aside from his knowledge, the author has drawn freely upon Flower's letters and published papers, while the first two chapters, dealing with his younger days, are written by Mr. Victor Flower, and Lady Flower contributes a charmingly written chapter on the latter portion of his life.

Educated for a surgeon, Flower joined the army during the Crimean war, and we learn that he showed conspicuous bravery under fire, was assiduous in his care of the wounded—though delighting in 'operations'—and ever desirous of improving the efficiency of the service.

From the portraits and context we gather that he was a man of fine presence, dignified, and courteous to all, and as he was of a sociable disposition, his friends were naturally many and included many of the most eminent men of the day.

Although successful as a surgeon, Flower's real work may be said to date from his appointment to the office of assistant surgeon at the Middlesex Hospital, which included the curatorship of the hospital museum. For, above all things, Flower was a 'museum man' in the widest acceptation of the phrase, and to him more than to any one else is due the educational character of modern museums. From his earliest youth he seems to have been destined for the position he subsequently held, and his crowning work at the British Museum was foreshadowed by 'the large, flat, shallow box' which he fitted with cardboard trays.

In December, 1861, he was appointed curator of the museum of the Royal College of Surgeons, a position he held for thirteen years, or until made director of the Natural History Museum, Flower being the first to bear that title, and here he remained until September 30, 1898, when he was forced to resign by failing health. Here it may be noted that the chapter dealing with his appointment is, in many ways, full of interest, as it contains many details relating to the growth and development of the British Museum which should be full of encouragement for museum officials on this side of the Atlantic. Those who know the British Museum only as it is, with its vast collections, magnificent and well-ordered exhibition halls and staff of efficient officers, may not know the long and difficult path by which these were attained nor realize that there was a time when the specimens were crowded and shabby and the staff decidedly underpaid. Flower may be said to have come in at the turn of the tide, when, after many years of struggle, a new building had been erected and the salaries of many of the officers substantially increased. Under his administration the collections steadily grew in number and importance, and while they all profited by his care, his immediate attention was given to the central hall whose exhibits form a comprehensive introduction to the study of systematic natural history. Here are to be found

specimens illustrating the subject of evolution, of adaptation to environment, protective coloration, natural variation and variation produced by man—as in domesticated animals—as well as series showing the characters and affinities of various groups of animals. In short, these collections form a museum in themselves, and it is along the educational lines laid down by Flower that modern museums are bound to progress. The old type of museum with its interminable and monotonous rows of scantily labeled specimens is, if not a thing of the past, a thing that is passing and the success or failure of the 'museum man' will be judged by the standard set by Flower.

Although devoting his energies mainly to museum work, he yet found time for original research and for a very considerable amount of literary labor, how much may best be gathered from the bibliography at the end of the volume. The 'Osteology of the Mammalia,' and 'Mammals, Living and Extinct,' the latter prepared with the collaboration of R. Lydekker and the outgrowth of articles in the 'Encyclopædia Britannica,' are his most comprehensive works and will always remain standard books of reference.

A man of high scientific attainments, the friend of Huxley, Darwin and Hooker, his greatest work was undoubtedly the impetus he gave the progress of science by making it not merely intelligible, but deeply interesting to the average observer from whom must ultimately come the support of scientific research.

F. A. LUCAS.

MUSEUM OF THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES.

DISCUSSION AND CORRESPONDENCE.

ANIMAL HEAT AND FEVER.

TO THE EDITOR OF SCIENCE: I have recently been engaged in a clinical study of fever, and as I am out of reach of any adequate reference library, I thought you would kindly permit me the use of your columns for a request for information as to the latest work which has been done on the problems of animal heat and fever.

The data which I have been able to collect appear to have established fairly clearly that fever is accompanied, not merely by diminished loss of heat (thermolysis), but also by increased production of heat (thermogenesis), *without increase of oxidation*.

The points upon which I should like information are:

1. Is animal heat, or body-temperature, to be regarded as a vital necessity, or merely an accompaniment of the really vital, metabolic changes? The perfection of constructive and growth processes not merely in cold-blooded animals, but particularly in plants, would appear to afford ground for this belief.

2. Have we any grounds for regarding the particular body-temperature of a given species of animal as roughly an index of the friction of the body-engine, and body heat as energy wasted?

3. Are the processes which control the temperature chiefly concerned with the dissipation of heat before it can have accumulated sufficiently to become injurious to the organism?

4. Are we justified in believing that the energy which enters into the normal activities of the body, secretion, motion, growth, is more nearly electrical than thermic in character?

5. Has the work done three or four years ago by Robin and Henrijean, showing that oxidation is not increased in fever (as measured by the oxygen intake and the carbon dioxid output), but on the contrary diminished, been supported by later research?

6. If this be true, are we justified in regarding fever as, to put it very crudely, an increase of friction in the vital machine, with consequent dissipation of heat, due to the disturbing influence of toxins, whether introduced from without or formed within the body?

The recent researches of Roger, Sanarelli and Metchnikoff show clearly that the natural effect of the toxin is to depress the temperature, and if the dose be large enough, or the resisting power of the animal sufficiently lowered, that depression will continue until death results in chill (hypothermia), without the occurrence of any reaction, or rise of temperature at all.

7. Would it not appear as if the increased temperature of fever was due to the sudden diversion by the toxin of all the energy which

normally goes into secretion, motion and growth, into the disproportionate production and waste of heat. The fact that while oxidation is not increased in fever, urea, uric acid and urinary nitrogen generally are markedly increased would certainly appear to point in this direction.

I should be greatly obliged for any references to recent work done upon any of these problems, or for any criticisms of the possible theory of fever or body heat here suggested.

Woods Hutchinson.

SPECIAL ARTICLES.

RECENT OBSERVATIONS UPON DÆMONELIX.

While in charge of a field party sent by the Carnegie Museum to northwestern Nebraska and Wyoming this season, the writer left camp early on the morning of July 4 to study and ascertain the contact between two geological horizons in the Loup Fork Miocene. On the way a locality showing an extensive development of *Dæmonelix* was found. These curious fossils were in great abundance in this place and presented a most imposing appearance. The first impression received was that of a petrified forest emerging from the soft sandstone and gradually disintegrating. For the purpose, if possible, of gaining some additional knowledge with reference to the remains of *Dæmonelix*, the origin and nature of which have led to considerable discussion, the writer stopped and began a systematic examination of the locality. After considerable time had been spent in searching among the broken specimens of *Dæmonelix*, some fragments of the skeleton of a rodent were found below a shelf of sandstone where a *Dæmonelix* partially disintegrated was lying. Carefully picking up the fragments and preserving them, the writer recalled the statement of Professor Barbour that he had found a skeleton of a rodent on the inside of one of these 'twisters' in 1891, and the search was continued with vigor.

It was not long until a nearly complete skeleton was found in the interior of a partially weathered 'rhizome,' which had the base of the upright spiral still in position. Apparently the animal had been in the act of going out—at all events the skeleton was lying with the head toward the exit, or the spiral portion of the *Dæmonelix*—when it was overtaken by some accident and died.

The work was now becoming interesting and everything else was forgotten in the quest for still further data to support what was rapidly growing to be a settled conviction in the mind of the writer as to the origin of these 'Devil's Corkscrews.' The work was carried on during the entire day in this locality and no less than six specimens of the remains of rodents were found, all of them on the inside of *Dæmonelix*.

The work was not restricted to this locality, but other localities were subsequently systematically worked. Bones were not only found in the transverse pieces or 'rhizomes' of the *Dæmonelix*, but they were also found in the vertical spirals. There were found skulls, jaws and portions of skeletons of what appear to be one and the same animal (*Steneofiber* ?). In all there are in the collection made for the Carnegie Museum from twelve to fourteen specimens of the remains of rodents, which were found in as many *Dæmonelices*. A portion of the material was gathered from the typical Nebraskan localities, where Professor Barbour secured the material of *Dæmonelix*, which he has so ably and exhaustively discussed in his papers, which have from time to time appeared in various publications.

It was a pleasure to meet Professor Barbour at his home in Lincoln, Nebr., and to have a discussion with him in regard to this question. Free access was accorded to all of the type specimens. That there are plant remains in the *Dæmonelices* has been thoroughly established. The relation of these rodents to *Dæmonelix* and the probable habits of the animals, and other questions which arise in this connection, may better be determined when the material has been cleaned up and prepared for thorough study. In the meanwhile the writer is led to believe from the facts above recited, that there is but little room to doubt that *Dæmonelix* is the cast of a burrow of a rodent.

When the material has been prepared for

study, fuller examinations will be made, and the results will appear in the publications of the Carnegie Museum. O. A. PETERSON.

CARNEGIE MUSEUM, PITTSBURGH,
August 18, 1904.

QUOTATIONS.

THE CANCER RESEARCH FUND.

AMONG the facts established by the report is that cancer can be successfully transplanted from any animal into another animal of the same species, but not into an animal of a different species; and this inoculability, so to speak, will hereafter be largely utilized for the purpose of obtaining cancer patients. A single cancer may in this way be passed on, so to speak, through several generations of animals, the original growth and those arising from it surviving all the hosts in which they have successively found the materials for their support; and it is further remarkable that the growth of cancer is found to be of a character unlike the growth of an individual. Every individual life, whether of plant or animal, springs from the union of two parent cells; but, when this union has been effected and the life of the new individual has commenced, its future growth is provided for and maintained by a simple division and subdivision of the cells entering into its several structures. In the case of cancer, however, it has been found that cell conjugation is continuous, and that the growth as a whole may therefore be regarded as a colony of individuals producing offspring, rather than as a part of the tissues of the subject in which it grows. It is so far definitely parasitical in its character; and it is suggested that the means of arresting it may probably be found in the employment of some method by which the cell conjugation occurring in its mass may be prevented. The inquiry will be pursued in this direction; but, while the bulk of the inoculation experiments hitherto instituted have been in small animals, and chiefly in mice, it will be necessary to use larger ones, of species whose life histories have been more carefully studied, for the purpose of investigating methods of treatment likely to prove applicable to the human subject. Perhaps all that can fairly be said, at this stage of the inquiry, is that the ground has been cleared of much error, and that paths apparently leading towards future progress have been brought to light.

It must be regarded as a matter for much congratulation that the evidence so far obtained does not confirm the popular belief in the increasing frequency of cancer; although Sir William Church, in his speech moving the adoption of the report, was careful to indicate that no absolute conclusion could be reached in relation to this part of the subject. The statistics obtainable, especially with regard to the past, are not sufficiently trustworthy to justify the formation of positive conclusions; while the improvements recently effected in microscopes, as well as in the methods of preparing tissues for examination, have rendered it more easy now than at any former time to pronounce authoritatively on the cancerous or non-cancerous character of any growth that is either removed from the living body or discovered after death. It will be seen from the abstract of the report that a considerable percentage of cases of suspected cancer have been discovered, on microscopic examination, not to be of that character; and the superintendent, Dr. Bashford, points out that this affords a probable explanation of a good many reputed 'cures' of the disease. A fact of equal importance is that really cancerous growths are not attended in their early stages by any special symptoms from which their character can be detected with certainty; and on this the report founds a strenuous recommendation that all growths which are even possibly cancerous should be removed by operation without delay.—The London *Times*.

NOTES ON INORGANIC CHEMISTRY.

RADIUM AND RADIOACTIVITY.

THE study of radium and radioactivity continues with unabated zeal, and new light is being continually thrown upon the subject. Naturally Sir William Ramsay must be recognized as one of the foremost workers, and whatever comes from him carries great weight. For this reason great interest attaches to a recent communication of his in the *Comptes Rendus* on the radium emanation, for

which he suggests the name *exradio*. Obtaining this radiation from a specimen of radium bromid, he finds that it possesses the properties of a gas, obeying Boyle's law, being condensed at a low temperature and having a vapor pressure still appreciable even at the temperature of liquid air. The gas, which is at first strongly luminous but only temporarily so, seems to be a member of the argon group, having a density of about 80. If monatomic this would give an atomic weight of about 160. This is but little less than would be expected for the next eighth group element above xenon, and it may turn out that the inert elements of this group present the best development found in the periodic table. From the fact of its large atomic weight it is clear that in the break up, if such there be, of each radium atom, but a single atom of the emanation is formed. The quantity of the gas available was but 0.0254 cubic millimeter, but this proved sufficient to obtain the volume-pressure relations.

In another paper in the *Proceedings* of the Royal Society, Ramsay and Soddy describe more fully these and other experiments. In numerous instances the helium spectrum appeared at once in the radium bromid emanation; in other cases the line D_3 appeared after one to three days, and later the complete helium spectrum. Fifty milligrams of radium bromid produced 0.5 cubic centimeter gas per day, chiefly hydrogen and oxygen in the proportion to form water, the remainder being almost entirely air. The amount of helium given off in sixty days was 0.1 cubic millimeter. From this it was calculated that a gram of radium would give off in a year 0.0022 milligram of helium. Since argon lines were noticed in the spectrum, the possibility is not absolutely excluded that both argon and helium *could* have come from an external source. The change in volume of the emanation was twice measured in minute capillary tubes. In one case it increased, in the other decreased. The tubes showed a brilliant helium spectrum. The amount of gas formed from the emanation was about 3×10^{-6} cubic millimeters per second per gram radium; the rate of decomposition of the emanation 3×10^{-11} cubic millimeters per second. The mean life of a radium atom is calculated as a little more than a thousand years. A cubic centimeter of the emanation would evolve eventually in complete decomposition 7.4×10^6 kal. and one gram of radium 10^9 kal., while one cubic centimeter of an oxygen-hydrogen mixture develops only 2.04 kal.

In a paper in the *Berichte*, Herbert N. McCoy discusses the decomposition of radium from the standpoint of the law of mass action. He considers the order of decomposition to be

$$Ur \rightarrow UrX \rightarrow Ra \rightarrow RaEm \rightarrow EmX \rightarrow He.$$

Since radium loses one thousandth of its mass per year, it must itself be the product of some mother substance which is itself decomposing at a much slower rate. This substance is uranium, which is always associated with radium. The content in radium must have reached a maximum in all ores which are more than 5,000 years old, and from this time on there must be a constant ratio between the uranium and radium. The radioactivity of all uranium ores should then be proportional to their content of uranium, and this McCoy finds to be the case. This has also been found to hold in a large number of minerals by B. B. Boltwood, an abstract of whose recent paper on the subject has lately appeared in SCIENCE. The activity of pure uranium salts is relatively only one fifth of that of uranium ores, owing to the fact that the latter contain also the intermediate and the decomposition products. The relative quantity of uranium X, radium emanation and emanation X to the amount of radium in any case is exceedingly small, owing to the rapidity with which they decompose. The ultimate decomposition product, helium, is a constituent of all uranium ores, but owing to diffusion its quantity bears no direct relation to the quantity of uranium in the ores. The absolute proportion of radium to uranium in ores is about one part radium to 300,000 parts uranium. The decomposition of thorium is analogous to that of uranium, but about one millionth part as rapid.

Curie and Labord have examined a large number of mineral springs from the standpoint of radioactivity and find great varia-

tions, the water from Gastein, for instance, being nearly a hundred times as active as that from Vichy. The activity of a water is greater at a spring than that of the same water after keeping for some time. The gas from a spring is often strong enough to blacken a photographic plate after several hours' exposure, though the intensity of action is very small in comparison with that of radium itself. The authors raise the question as to whether it is possible that the therapeutic action of certain waters can be connected with their radioactivity.

Bouchard, Curie and Balthazard have experimented upon the physiological effect of the emanation, and find that it has a marked toxic action on inhalation, producing intense congestion of the lungs. The tissues after death show a decided radioactivity.

Veneziani has tested the action of radium rays upon the protozoon *Opalina ranarum* from the intestinal canal of the frog. While the organism dies very soon after removal from its normal habitat, under the influence of a radium preparation of 10,000 units it lives much longer and preserves its activity. From this the author concludes that while radium often has a destructive influence upon the living cell, this action is by no means uniform, and the radium may sometimes have the opposite effect.

The great sensitiveness of recent methods of detecting minute quantities of emanations and infinitesimal radioactivity is compared by Berthelot with the sensitiveness of the nerves of smell for certain odors. For example, he cites the odor of iodoform, which can be recognized in quantities as small as one hundred billionth of a gram. In such a case a distinct odor could be perceived even though a gram of the substance would not lose a thousandth part of its weight in hundreds of years. He calls attention to the risk of inferring from spectroscopic methods the change of one element into another, inasmuch as the sensitiveness of the spectroscope belongs to the same order of delicacy. It is well possible that the indication of spectral lines of one element might appear in the spectrum of another, owing to the presence of an infinitesimal amount of the element as an impurity.

J. L. H.

ANCIENT NATURAL HISTORY LORE.

AN interesting article is contributed to *Nature* (Vol. LXX., p. 207) by Dr. R. Lydekker on portraits of mammals preserved in ancient Egyptian inscriptions. The amount of research which has been carried on in this line of late years is considerable, the most elaborate contribution being the recently published memoir of Lartet and Gaillard on the mummified animals of Egypt.* To the zoologist these investigations are valuable chiefly for their bearing upon questions of geographical distribution and minor variation, but to the archeologist their interest is much greater and more general.

In calling attention to the fact that no mean harvest of information may be gleaned from this ancient field, it goes almost without saying that a rich reward awaits him who will critically reexamine and collate the mass of fact contained in classic writings on natural history, though it is clear the task of eliminating fancy, fable and rank superstition is not an easy one. That a good beginning has already been made, so far as relates to the more familiar animals, will not be disputed by any one who has examined Otto Keller's 'Thiere des classischen Alterthums' (Innsbruck, 1887), a work of great interest alike to the naturalist and antiquarian. This book, however, falls short of completeness, the omissions including even such important creatures as the lion, elephant and rhinoceros.

Regarding the lion in particular, it must be confessed that the grossest ignorance and misconceptions prevailed not only in classic times, but until well along in the middle ages. One of the most surprising fallacies entertained concerning both the lion and panther was that parturition occurred but once during lifetime, each pair producing a single cub, and each generation consequently being not more than half as numerous as the preceding. The theory of spontaneous generation came in

* *Archives Muséum d'Hist. Nat. de Lyon*, Vol. VIII., No. 2, 1903.

handily to explain the non-extinction of species. On this point the second century writer, Aulus Gellius, in his highly prized 'Attic Nights' (xiii, 7), has left on record the following interesting observations:

"Herodotus has related in his third book that the lioness produces but once in its life, and at that birth never more than one whelp. But Homer says that lions produce and bring up many whelps, these being the lines in which he plainly asserts this:

> Thus in the center of some gloomy wood,
> With many a step, the lioness surrounds
> Her tawny young, beset by men and hounds.
> * * * * * * * *

"When this difference and opposition of sentiments between the most celebrated poet and most eminent historian greatly perplexed me, I thought proper to consult Aristotle's exquisite 'Historia Animalium,' and whatever he has there written upon this subject, I have put down in these commentaries. His statements are found in book VI. [as follows]:

"That the lion copulates backwards and is retromingent, has been mentioned before. But it copulates and produces not at all seasons, though in every year. It produces in the spring, and generally has two offspring. When its produce is most numerous it has six, but sometimes it has only one. It is an idle story which tells us of the lioness, that when she brings forth her young, she loses the future power of generating, and it arises from the scarcity of the lion's race, for the kind is rare, not known in many places and nowhere in Europe except in that country which is between the river Achelous and the Nessus. * * * The Syrian lions produce five times in their life, at first five cubs, then one less every time, after which they become barren."

In that mystical early Christian bestiary, whose unknown author is called the 'Physiologus,' and whose authority was widely accepted throughout Europe during the middle ages, three peculiarities are claimed for the lion. First, to throw hunters off his tracks he rubs out his footmarks with his tail. Secondly, when the lion sleeps, his eyes never close. Thirdly, the lioness bears her cub dead, but on the third day his sire comes, breathes into his face, and thus brings him to life. These attributes were all supposed to have a deep religious significance, the meaning of which has been explained by the commentators of 'Physiologus.' Dante's idea of the lion forms the subject of a special chapter in R. T. Holbrook's 'Dante and the Animal Kingdom' (1902).

C. R. Eastman.
Harvard University.

THE BRITISH ASSOCIATION.

The Cambridge meeting of the British Association adjourned on August 24 to meet at Cape Town, South Africa on August 15, 1905. The attendance at the Cambridge meeting was 2,789, the largest except on five previous occasions—at Manchester in 1861, at Newcastle in 1863, at Bath in 1864, at Manchester in 1887 (the largest meeting ever held), and at Liverpool in 1896.

Scientific grants to the value of £1,000 were made, as follows: Mathematical and Physical Science.—Electrical standards, £40; Seismological observations, £40; investigations of the upper atmosphere (kites), £40; magnetic observations, £50. Chemistry.—Aromatic nitramines, £25; dynamic isomerism, £20; wavelength tables of spectra, £5; study of hydroaromatic substances, £25. Geology.—Movements of underground waters, balance in hand; life zones in British carboniferous rocks, balance in hand; fossiliferous drift deposits, balance in hand; erratic blocks, £10 and unexpended balance; fauna and flora of British trias, £10. Zoology.—Index animalium, £75; table at zoological station at Naples, £100; development of frog, £10 and unexpended balance; higher crustacea, £15 and unexpended balance. Geography.—Investigations in the Indian Ocean, £150. Economic science and statistics.—Trade statistics, £20. Anthropology.—Age of Stone Circles, £40; anthropometric investigations, £10; excavations on Roman sites in Britain, £10; excavations in Crete, £75 and unexpended balance; anthropometry of native Egyptian troops, £10; Glastonbury Lake Village, balance in hand; anthropological teaching, balance in hand. Physiology.—Metabolism of individual tissues, £30 and unexpended balance; state of solution

of proteids, £20; the ductless glands, £40. Botany.—Structure of fossil plants, £50; physiology of heredity, £35; botanical photographs, £5. Educational Science.—Studies suitable for elementary schools, £20. Corresponding Societies Committee, £20.

We hope to receive accounts of the scientific work of the meeting, which according to the programs were of more than usual interest and importance.

THE EIGHTH INTERNATIONAL GEOGRAPHIC CONGRESS.

As we have already announced, the eighth International Geographic Congress will meet in the United States, beginning at Washington, on September 8. It will reconvene in Philadelphia on September 12, at 9 o'clock; and again in New York on September 13, at 10 o'clock. After a field meeting at Niagara Falls on September 16, it will reassemble in Chicago on September 17, at 10 o'clock; and it will finally convene in St. Louis, in conjunction with the International Congress of Arts and Science on September 19, at 10 o'clock.

Among the more detailed arrangements for the members, it may be noted that there will be an informal reception at Hubbard Memorial Hall of the National Geographic Society on the evening preceding the meeting; a reception by Mrs. Gardiner G. Hubbard, on September 9, and a reception by Commander and Mrs. Peary, on September 10; Professor E. von Drygalski will give a lecture on the evening of September 9.

At Philadelphia, members will be entertained by the Geographical Society; a luncheon will be given by the University of Pennsylvania, and dinner will be provided in the evening. In New York the members will be entertained by the American Geographical Society, which offers a reception on September 13, and there will be a dinner on September 14; luncheon will be served at the American Museum of Natural History; Sir John Murray will make an address, introducing a discussion on oceanography. On September 15 there will be an excursion up the Hudson River to Mt. Beacon, on the steamer *Richmond*, and a visit to West Point. Professor W. M. Davis, of Harvard University, will conduct the field meeting on Mt. Beacon. At Niagara Falls, on September 16, Mr. G. K. Gilbert, of the U. S. Geological Survey, will give an address on the geographic development of the cataract, and a field meeting will be held in charge of geographers familiar with the region.

At Chicago, on September 17 and 18, members will be entertained by the Geographical Society of Chicago and by the University of Chicago. On Monday, Tuesday, Wednesday and Thursday, the congress will meet with the International Congress of Arts and Science, at St. Louis. Commander Peary, the president of the congress, will give an address on the evening of December 20, and the closing session will be held on September 22.

At the various scientific sessions a very large number of papers will be presented. They are classified as follows: physiography, mathematical geography, biogeography, exploration, technique, historical and educational. The president of the United States is honorary president of the congress, and apparently all the foreign ambassadors and ministers are honorary vice-presidents; the general secretary is Mr. Henry Gannett, and the treasurer is Mr. J. J. Edson; Dr. W J McGee is chairman; and Dr. J. H. McCormick, secretary of the committee of arrangements.

A cordial and specific invitation is given to all persons interested in the science of geography to become members of the congress and participate in its proceedings. Application for membership, the fee being $5, should be addressed to The Eighth International Geographical Congress, Hubbard Memorial Building, Washington, D. C.

THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE.

A MEMORANDUM has been issued for the use of foreign speakers at the Congress of Arts and Science. A New York reception committee has been formed, with Mr. F. P. Keppel, secretary of Columbia University, as chairman. The members of the committee will so far as possible meet the guests on arrival. Professor Hugo Münsterberg, one

of the vice-presidents of the congress, expects to be at the Manhattan Hotel from September 9 to 14. The visitors will be entertained at the University of Chicago from September 15 to 17. After the congress at St. Louis, they will proceed to Washington, and will be received by President Roosevelt on the twenty-seventh. Visits will be made to the Johns Hopkins University, the University of Pennsylvania and Princeton University. From October 2 to 5 will be spent in Boston; a reception will be given by Professor Münsterberg, a luncheon by the Harvard Corporation and a banquet by the professors of Harvard University and the Massachusetts Institute of Technology. October 6 will be spent at Yale University, and the closing festivity will be held on October 8 under the auspices of the Association of Old German Students in New York.

We hope that any readers of SCIENCE, who, owing to absence from home during the summer holidays or for other reasons, did not see the last number of SCIENCE will turn to it and read the invitation extended to American men of science by President Butler, chairman of the administrative board, and Professor Newcomb, chairman of the organizing committee, and the article by Professor Münsterberg, vice-president of the congress. It is desirable that as many American men of science as possible be present at St. Louis from September 19 to 25 as an act of courtesy to the foreign visitors, no less than from enlightened self-interest.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR HUGO DE VRIES, professor of botany at the University of Amsterdam, gave the convocation address at the University of Chicago, on September 2. The degree of LL.D. was conferred on him.

AT the conclusion of the address of Mr. C. A. Parsons, as president of the Engineering Section of the British Association, he was presented by Dr. Schröter with the gold medal of the German Society of Civil Engineers.

A PRIZE in chemistry, to be awarded every second year for the best doctor's dissertation in chemistry, has been established in honor of the seventieth anniversary of the birth of Professor U. Schiff, of Florence.

DR. H. H. RUSBY, professor of botany and materia medica, in the New York College of Pharmacy, Columbia University, is at present studying the collections at Kew.

SIR WILLIAM RAMSAY, the retiring president of the Society of Chemical Industry, which is meeting in New York this week, reached New York on the first instant.

DR. S. KITASATO, the well-known Japanese bacteriologist, is among the eminent men who have recently arrived in this country to attend the approaching Congress of Arts and Science at St. Louis.

THE Honorable Carroll D. Wright, U. S. Commissioner of Labor, will retire from this office on December 1, when he will assume the active presidency of Clark College.

PROFESSOR G. H. BARTON, of the Massachusetts Institute of Technology, and a party of students, are at present in the Hawaiian Islands studying their geology.

MR. J. E. BURBANK, of the University of Maine, has been appointed to a position in the U. S. Magnetic Survey, Washington.

MR. F. C. WILLCOCKS, demonstrator in entomology and botany in the Southeastern Agricultural College, Wye, has been appointed entomologist to the Khedivial Agricultural Society at Cairo.

THE president of the British Board of Education has appointed Mr. W. I. Last, A.M.I.C.E., senior keeper in the science division of the Victoria and Albert Museum, to be director of that division of the museum, in the place of Major-General Festing, C.B., F.R.S., who has recently retired at the age of 64 on the operation of the age limit.

WE learn from the London *Times* that the Hugh Miller Memorial Institute at Cromarty was opened on August 26, by Mr. Andrew Carnegie. The institute, which had its inception at the Hugh Miller centenary celebrations two years ago, is a short distance from the house where the geologist was born, and the accommodation provided includes a public library. The site was given by Colonel Ross, of Cromarty, the cost of the building, amounting to £1,200 was defrayed by Mr. Carnegie, and the public subscribed £400 for an endowment

fund. Mr. Carnegie further defrayed the expense of publishing the report of the centenary proceedings.

MR. EMIL MAHLON, topographical draughtsman of the Navy Department and a landscape engineer, died on August 31.

THE Rev. George Pirie, professor of mathematics in the University of Aberdeen, died on August 21, at the age of sixty-one years.

PROFESSOR ERICH BENECKE, of the University of Berlin, has died from blood poisoning, after an operation he carried out.

ON September 14 there will be a civil service examination to fill a vacancy in the position of assistant in animal husbandry in the Bureau of Animal Industry, Department of Agriculture, at $1,200 per annum. On September 21 and 22 there will be an examination to fill a vacancy in the position of artist (female), at $900 per annum, in the Bureau of Forestry, Department of Agriculture.

THE Harvard Observatory has acquired a 60-inch reflecting telescope, made by the late A. A. Common.

M. DURAND has presented to the Paris Museum of Natural History his herbarium and botanical library with $1,000 to defray the cost of installation and $10,000 as an endowment fund.

PROFESSOR MOSSO, of Turin, and Signor Pagliani, the president of the Italian Alpine Club, have selected a site on Monte Rosa, at a height of 3,000 meters for the erection of an Alpine research station. It is hoped that it will be in working order in 1906.

THE National Antarctic relief ship, the *Morning*, arrived at Port Stanley, in the Falkland Islands, on July 17, after a fine weather passage round Cape Horn, but with a high-pressure cylinder cracked. The *Discovery* was at Port Stanley on July 17, but has since left. Some time was taken up in coaling the *Morning*, and apparently she left the Falkland Islands about July 29. She is expected to arrive off Plymouth about September 29.

THE statistics of the enrolment at the recent meeting of the National Educational Association held at the St. Louis Exposition have been published. The total membership was 4,873. This was largely local in character, the enrolment from Missouri being 2,264. There were only 282 members in attendance from the north Atlantic states.

THE American Röntgen Ray Society will hold its fifth annual meeting at St. Louis from September 9 to 13.

THE present year being the jubilee of the British Society of Engineers, the council have decided that the event shall be celebrated by a *conversazione*, to be held on the evening of November 16.

PROFESSOR ROBERT KOCH has given his permission to the publication in the London *Times* of a translation of a private letter to Mr. G. A. Heron in which he says: "It will interest you to hear that the experiments which were made at my suggestion in the Imperial Institute of Public Health concerning human and bovine tuberculosis are practically complete, and quite bear out my views. These experiments were carried out on such a number of animals, and with so much care, that they are, I firmly believe, incontrovertible. Besides this, these experiments were made during my absence (in Africa), and, therefore, were not influenced by me. They prove that bovine and human tuberculosis are different from one another. Cattle can not be infected with human tuberculosis. In very rare instances can man be infected with bovine tuberculosis. This work will be published in detail in a few months."

THE *Scottish Geographical Journal* states that Mr. W. N. Macmillan has carried out his intention of renewing his attempt to find a commercial river-way between Abyssinia and the Egyptian Sudan, and some details in regard to his new expedition are now available. So far the expedition is stated to have proved two important things. It has, in the first place, shown the possibility of navigation up the Sobat and Baro Rivers to the Gambela Cataract at the foot of the Abyssinian plateau. This was demonstrated by Mr. Macmillan's launches at the lowest water, although the view was held by the Sudanese government

that the passage of the rivers would be quite out of the question. A second point of considerable value is the demonstration of the fact that the Boure heights forming the ascent of the Abyssinian highlands, which have always been held to be inaccessible for loaded animals, were successfully climbed by the expedition, and that of all the caravan mules and donkeys not a single one was unloaded during the climb. The expedition, consisting of Sir John Harrington, Mr. and Mrs. Macmillan, Mr. Bulpit, Dr. Charles Singer, medical officer, Mr. Jessen, engineer and surveyor (in charge of the launches), a taxidermist, and the usual servants, left Khartum in January in a government steamer for Nasser, the two expeditionary launches, *Sobat* and *Adis Abeba,* being towed behind. On leaving the government steamer, the party embarked in the smaller vessels, by which they steamed without mishap of any kind to the foot of the Abyssinian Hills, where they were stopped by the Gambela Rapids of the Baro River, where navigation ceased, and all the travelers landed. A base camp was formed at Pokum, in the heart of the Annak Country, at the base of the Abyssinian Hills, amid delightful scenery. The expedition was to leave Pokum on April 20, via Mela, for the western coast of Lake Rudolf, in which region the travelers would remain until November, afterwards returning to the coast, via Adis Abeba and Jibutil.

In addition to its force engaged in forest-reserve work, the Bureau of Forestry has this summer 116 skilled men in the field. Of these 68, scattered in 26 states, are studying commercial trees, making working plans for woodlots and forests, and gathering data invaluable for the proper management of wooded areas. The remaining 48 experts, divided among 10 other states, are studying means of replacing the forest on lands from which it has been denuded, making planting plans for tracts to be forested, and planting in the western forest reserves. The data they will gather will be worked over and condensed by the office force this winter, and put into shape for practical use. Reports from the field which are coming in daily show that the year is to be one of distinct achievement and that the work is progressing everywhere with important advance in American forestry. These experts, in covering their various territories, are zealous missionaries in the cause they serve, for wherever their work carries them the purpose of forestry, its methods, and its incalculable importance to the general welfare are understood, appreciated and applied as never before.

We learn from the *Experiment Station Record* that there has been recently established by the National Society of Agriculture of France, a committee for the purpose of securing and erecting a monument to the memory of the late Louis de Vilmorin. The list embraces the names of many individuals who are prominent in agriculture and allied subjects in France and elsewhere. The American membership consists of Professor C. S. Sargent, director of the Arnold Arboretum, Boston, Mass.; Dr. William McMurtrie, president of the Chemical Society of New York and D. M. Ferry, seed dealer, Detroit, Mich.

UNIVERSITY AND EDUCATIONAL NEWS.

The Iowa State College has established a chair of forestry with Mr. Hugh P. Baker as professor. He will lecture at the college half of each year on general forestry in its application to Iowa conditions. The other half of the year he will devote to bureau work, for the most part investigating forest problems as they concern the state of Iowa.

At University College, London, Professor Oliver has been reappointed to the Quain chair of botany.

At Cambridge University Mr. H. E. Durham, M.A., M.B., King's College, has been elected to a John Lucas Walker studentship for original research in pathology, and a second studentship on the same foundation has been adjudged to G. S. Graham-Smith, M.A., M.B., Pembroke College.

Professor von Eiselsberg, Vienna, has declined a call to the chair of surgery at the University of Berlin.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 16, 1904.

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THE LOBACHEVSKI PRIZE.

THE third award of the great Lobachevski prize was the occasion for considering particularly the achievements of two men during the past five years. The first of these is Professor Hilbert, of Goettingen; the second, Professor Barbarin, of Bordeaux.

The committee asked from the most distinguished of French mathematicians, Poincaré, a report on those works of Hilbert relevant to the decision.

With French thrift, Poincaré used as the greater part of this report a review of Hilbert's 'Grundlagen' which had already been published three times, two parts of which I quoted in my St. Louis address, to point out two errors (SCIENCE, N. S., Vol. XIX., No. 480, pp. 401–413). But the works to be considered included others which had only appeared after that review was written, so that Poincaré was compelled to recast and supplement this review of his, and some of these additions are of high interest.

Our ideas, he says, on the origin and scope of geometric verities have, since a century, evolved in a very rapid way. The creations of Lobachevski, of Bolyai, of Riemann have inaugurated a new era. Certes they have not discouraged the men, only too numerous, who seek to demonstrate the postulatum of Euclid. These, alas! nothing could discourage. But they have convinced all the true savants of the inanity of such an attempt. This was the first result of the invention of the non-Euclidean geometries. Lie pushed the

matter farther, but his spaces were all assumed by him to be number-manifolds.

A new progress remained to be accomplished, and the honor of this belongs to Hilbert. It is important, however, to say a word of the works which have prepared and rendered possible this advance.

Since the time of Lobachevski, mathematical thought has undergone a profound evolution, not alone in geometry, but in arithmetic and analysis. The notion of number has been made more clear and precise; at the same time it has received diverse generalizations. The most precious for the analyst is that which results from the introduction of neomonics, which modern mathematicians could not now dispense with.

Again, many Italian geometers, such as Peano and Padoa, have created a *pasigraphie,* that is to say, a sort of universal algebra where all reasonings are replaced by symbols or formulas.

Finally must be cited the book of Veronese on the foundations of geometry, where the author applies for the first time to geometry the transfinite numbers of Georg Cantor.

In 1899 Hilbert published a memoir entitled 'Grundlagen der Geometrie,' full of ideas the most original. Moreover, this was not the first time he had occupied himself with analogous questions, witness his letter of 1894 to Felix Klein: 'Ueber die gerade Linie als kürzeste Verbindung zweier Punkte.' He has since published in divers journals a series of articles entitled: 'On the theorem of the equality of the basal angles in the isosceles triangle'; 'New founding of the Bolyai-Lobachevski geometry'; 'On the foundations of geometry'; 'On surfaces of constant Gaussian curvature.'

All these articles have been united in a second edition of his jubilee memoir; and I must add that this second edition contains a series of improvements and additions which greatly augment its value.

It is, therefore, this second edition that we will follow in our analysis; but we will join with it, on the one hand, other works of Hilbert, such as his article 'Ueber den Zahlbegriff' and his Paris address on the mathematical problems of the future, and, on the other hand, many theses written by his scholars, under his direct inspiration, and which consequently aid us in comprehending his thought. The principal are: 'Ueber die Geometrieen in denen die Geraden die kürzesten sind' by Georg Hamel, and 'Die Legendre'schen Sätze ueber die Winkelsumme im Dreieck' by M. Dehn.

"Hilbert commences," continues Poincaré, "by establishing the complete list of axioms, straining not to forget one.

"Is his list final? It is permitted to believe so, since it seems to have been drawn up with care."

So says Poincaré for the fourth time. But if Hilbert's receiving the Lobachevski prize depended on his list of axioms being '*définitive,*' it could not be given to him. A young pupil of my own, R. L. Moore, by a charmingly simple proof has abolished the ugliest of the list, and Hilbert has already acknowledged the redundancy. Another point Hilbert himself changed in the French translation of his 'Festschrift' by Laugel. Poincaré had said: "The axiom that the sect AB is congruent to the inverse sect BA (which implies the symmetry of space) is not identical with those which are explicitly stated. I do not know whether it could be logically deduced from them; I believe it could."

In his 'Report,' Poincaré now says: "An important point is not here treated; the list of axioms should be completed by saying that the sect AB is congruent to the inverse sect BA.

"This axiom implies the symmetry of

space and the equality of the angles at the base in an isosceles triangle. Hilbert does not here treat this question, but he has made it the object of a memoir to which we will recur." This is a mistake. Hilbert explicitly assumes $AB \equiv BA$, but the equality of the basal angles does not follow therefrom.

It used to be supposed that the Euclidean straight was of essence continuous, and this putative continuity was rested upon to give continuity to the real number system. This mistake is made by Professor H. B. Fine in his book 'The Number-system of Algebra.' For example, on page 43 he says: *"The entire system of real numbers,* however, inasmuch at it contains an individual number to correspond to every individual point in the continuous series of points forming a right line, *is continuous."*

Dedekind had long ago called attention to the fact that Euclid's space had no need of continuity. In an article of my own 'How the new mathematics interprets the old,' March 4, 1893, is a quotation of his construction of a discrete space, which goes on, "yet despite the discontinuity, the perforation, of this space, all constructions occurring in Euclid are in it just as achievable as in perfectly continuous space. The discontinuity of this space would, therefore, never be noticed, never be discovered, in Euclid's science. Um so schoener erscheint es mir, das der Mensch ohne jede Vorstellung von messbaren Groessen, und zwar durch ein endliches System einfacher Denkschritte sich zur Schoepfung des reinen, stetigen Zahlenreiches aufschwingen kann; und erst mit diesem Hülfsmittel wird es ihm nach meiner Ansicht moeglich, die Vorstellung vom stetigen Raume zu einer deutlich auszubilden."

There are naturally no points on the Euclidean straight to correspond to the series of irrational numbers, and Euclid felt no more ambition to have them there than he did to have a set of automobiles, and for the same reason, irrational numbers and automobiles had not yet been created.

Hilbert's axioms, analyzing Euclid's space, did not make it continuous. Poincaré called attention to this, and spoke of the space burdened with these irrational points as *our* space in contrast to Euclid's space, as if we were debarred by modernity from living in the splendidly free and disjointed space of the glorious old Alexandrian, who spurned the idea of any other way even for kings. "In Hilbert's space," he says, "there are not all the points which are in ours, but only those that one could construct, starting from two given points, by means of the ruler and compasses. In this space, for example, there would not exist, in general, an angle which would be the third part of a given angle.

"I have no doubt that this conception would have been regarded by Euclid as more rational than ours."

He then proceeds, following Dedekind, to give an assumption which will lug in these irrational points. Hilbert in Laugel's translation did the same, but by a quite different assumption, which he calls the 'Axiom der Vollständigkeit.'

"Note. We remark that to the five preceding groups of axioms one may still add the following axiom which is not of a purely geometric nature and which, from the theoretical point of view, merits particular attention.

"AXIOM OF COMPLETENESS.

"To the system of points, straights and planes, it is impossible to add other beings (êtres) so that the system thus generalized forms a new geometry where the axioms of the five groups I.–V. are all verified. In other words: the elements of geometry form a system of beings which, if one maintains

all the axioms, is not susceptible of any extension."

In speaking of the non-Archimedean geometry, the 'Review' made no mention of Veronese. The 'Report,' however, says: "In this conception, so audacious, Hilbert had had a precursor. In his foundations of geometry Veronese had had an analogous idea. Chapter VI. of his introduction is the development of a veritable arithmetic and of a veritable geometry non-Archimedean where the transfinite numbers of Cantor play a preponderant rôle. Nevertheless, by the elegance and the simplicity of his exposition, by the depth of his philosophic views, by the advantage he has obtained from the fundamental idea, Hilbert has made the new geometry his own."

The 'Report' is in 39 pages. The incorporation of the already published 'Review' stops with page 25. The last fourteen pages are entirely new, as follows: The memoir we have just analyzed puts in evidence the importance of the new non-Archimedean geometry. It discusses the rôle of the axiom of Archimedes in geometric reasoning; and the principal result of this discussion may be summed up thus: If we abandon this axiom and retain only the axioms of the first four groups, the essential results of Euclidean geometry are not altered; but this is not so if one retains only the projective axioms [assumptions of association] and those of order [betweenness], together with the postulatum of Euclid, but abandons at the same time the axiom of Archimedes and the metric axioms [assumptions of congruence]; we come then to the non-Pascalian geometry.

Then comes the question, does this that we have just said of the Euclidean geometry remain true of the Lobachevskian?

In other words, if we preserve only the axioms of the first three groups (projective, of order and metric) and replace the postulatum of Euclid by that of Lobachevski, shall we arrive at the fundamental theorems of Lobachevski *without using the axiom of Archimedes*?

This is the question that Hilbert has settled in his article 'Ueber eine neue Begründung der Bolyai-Lobatschefsky-schen Geometrie.'

He answers it affirmatively and shows in particular that there always exists a common perpendicular to two straights of the plane which do not meet without being parallel.

I would call attention to the statement of the postulate of Lobachevski: "If b is any straight of the plane and A a point not situated on this straight, there pass always through A two demi-straights [rays], a_1 and a_2, which are not in the prolongation one of the other and which do not cut the straight b, while every semi-straight passing through A and situated in the angle formed by a_1 and a_2 meets b."

"It is these two demi-straights, a_1 and a_2, which have received the name of *parallels*." They do not meet the straight b, but they serve as *limit* to the angle wherein are found the straights which meet b and to the angle wherein are found the straights which do not meet b.

I would signalize an elegant theory of what might be called the points at infinity of the Lobachevskian plane, and of which the laws are the same as those of the addition and the multiplication of real numbers. One may draw thence a very simple and very suggestive exposition of the non-Euclidean geometry.

The origin of our acquaintance with the theory of parallels is found in the theorems of Legendre which establish a necessary correlation between the sum of the angles of a triangle and the choice between the three geometries, Euclidean, Lobachevskian, Riemannean.

What rôle does the axiom of Archimedes

play in these theorems? This question interested Hilbert and under his inspiration M. Dehn has made it the subject of a thesis which I can not pass over in silence. The conclusions of Dehn show that without the axiom of Archimedes the theorems of Legendre are no longer true.

It is still true that if *one* triangle has the sum of its angles equal to (or greater than) (or less than) two right angles the same is true of all the others. It is still true that if this sum is less than two right angles, one can draw many parallels to a straight through one point. It is true that if it is greater than two right angles, the postulatum of Euclid is false, and that if it is equal to two right angles it is impossible that two straights always meet, but *the other theorems of Legendre are not true.*

There exists a plane geometry where, the sum of the angles of a triangle being greater than two right angles, one can draw to a straight through one point an infinity of parallels (so I call straights which do not meet); this is the *non-Legendrean* geometry.

A geometry exists where the sum of the angles is equal to two right angles, and where one can draw to a straight through one point an infinity of parallels. This is the *semi-Euclidean geometry.*

It will suffice to explain here what this latter is, the former being altogether analogous. For this it is necessary to return to what I have said of the non-Archimedean geometry. I have explained how the non-Archimedean plane is deduced from the ordinary plane by the adjunction of new points; how for deducing a non-Archimedean straight D_1 from the ordinary straight D_0, it is necessary to add to it:

1. On the one hand, an infinity of new points between every two demi-straights S' and S'' of which the totality forms D_0.

2. On the other hand, an infinity of new points to the right of all the ordinary points of D_0, and an infinity of new points to the left of all the ordinary points of D_0. Well, retain the new points of the first sort, that is to say, those which are at a finite distance, and suppress the new points of the second sort, that is to say, those which are at an infinite distance.

Then let D be any straight and A any point; then there will be an infinity of straights passing through A and which do not meet D, those, namely, which would have met it in one of the new points of the second sort, if these points had not been suppressed. However, all the theorems of Euclid remain and every rotation or every translation will transform into itself the non-Archimedean plane so mutilated.

It seems that here is a contradiction with the results of the article just cited: 'Ueber eine neue Begründung. * * *'

If, as Hilbert has shown, the geometry of Lobachevski can be deduced from his postulate without the intervention of the axiom of Archimedes, how can there be a geometry semi-Euclidean, that is to say a geometry where the theorems of Euclid accord with the postulate of Lobachevski?

It seems that this difficulty springs from this, that the enunciation of the postulate is not the same in the two cases.

Dehn assumes that through a point one can draw an infinity of straights which do not meet a given straight, and an infinity of straights which meet it.

The first form an ensemble E_1, the others form an ensemble E_2. Hilbert supposes, in addition, that there exists a limiting straight which appertains to the ensemble E_1, and such that every straight comprised between this limit straight and a straight of E_2 appertains likewise to E_2. It is this limit straight which Hilbert considers as the *parallel properly so called.*

In the geometry of Dehn this parallel

properly so called does not exist. Here would be an interesting question to examine closely. Is it possible to construct a non-Archimedean geometry where this parallel properly so called exists and to which are applicable the results of Hilbert?

An analogous question is treated in another article by Hilbert, 'Ueber die Gleichheit der Basiswinkel im gleichschenkligen Dreieck.'

In the ordinary plane geometry, the plane is symmetric, which expresses itself by the equality of the angles at the base of the isosceles triangle.

One should make this *symmetry of the plane* figure in the list of metric axioms. In all the geometries more or less strange of which we have hitherto spoken, in those at least where one admits the metric axioms, in the metric non-Archimedean geometry, in the new geometries of Dehn, in those which have made the subject of the memoir 'Ueber eine neue Begründung * * *' this symmetry of the plane is always assumed. Is it a consequence of the other metric axioms? Yes, as Hilbert shows, if one admits the axiom of Archimedes. No, in the contrary case.

There are non-Archimedean geometries where all the metric axioms are true, with the exception of this of the symmetry of the plane. Here is an example:

The non-Archimedean numbers previously defined may be infinite or finite or infinitesimal; but an angle will be always finite or infinitesimal because of the relation

$$\cos^2\varphi + \sin^2\varphi = 1.$$

An angle may, therefore, always be put under the form $\theta + \tau$, θ being an ordinary real number and τ a non-Archimedean infinitesimal.

We define then the rectangular coordinates of a point, the straights and the translations in the ordinary manner and define rotation in the following manner. Let α, β be the coordinates of the center of rotation; $\theta + \tau$ the angle of rotation; x, y the coordinates of any point before the rotation; x', y' its coordinates after the rotation; one will have

$$(x' - \alpha) + i(y' - \beta) = e^{i(\theta+\tau+i\tau)}[(x - \alpha) + i(y - \beta)].$$

Consider the group formed by the rotations about the origin. This group will not be permutable for the transformation which changes y into $-y$, nor for any transformation which retains the origin, which changes straights into straights and of which the square reduces to the identical transformation. *The plane is, therefore, not symmetric.*

All the other metric axioms subsist, however, as does also the postulatum of Euclid and even a new axiom which Hilbert calls *Axiom der Nachbarschaft* and which he states thus:

"Given any sect AB, one can always find a triangle in the interior of which can be found no sect congruent to AB."

This results easily from the equation of the circle. The equation of a circle of radius ρ and center α, β is in fact:

$$(x-\alpha)^2 + (y-\beta)^2 = \rho^2 e^{2\tau};$$

$$\frac{y-\beta}{x-\alpha} = \tan(\theta + \tau).$$

In return, it is not true that the angles at the base of an isosceles triangle are equal; it is not true that in a triangle one side is less than the sum of the other two; finally the theorem of Pythagoras on the square of the hypothenuse is not true.

"It is for this reason that this geometry is called *non-Pythagorean.* [I may interpolate here that Poincaré is in error in saying Hilbert shows that the equality of the basal angles can be proved from the other metric axioms if one admits the axiom

of Archimedes. In addition the new Axiom der Nachbarschaft is used.]

"I come to speak now of an article entitled 'Ueber die gerade Linie als kürzeste Verbindung zweier Punkte' that I can not separate from a thesis on the same subject, written by Hamel under the inspiration of Hilbert. Here we are less far from home; not only is there no question of renouncing the axiom of Archimedes, but we encounter only analytic functions which may be differentiated and integrated.

"Suppose that one has defined straights in the ordinary fashion and that one admits the projective axioms, those of order and the theorems of Desargues and Pascal. Define now the length of an arc of any curve; it is not necessary to choose this definition so as to satisfy the metric axioms, that is to say so as to render possible the movement of a rigid figure.

"Is it possible so to make this choice that the straight line shall be the shortest path from one point to an other?

"The definition of the straight is not changed, but that of the circle is in a very large degree arbitrary; it is only necessary that all the circles which have their center on a straight and which pass through a point of this straight have at this point the same tangent. The problem permits an infinity of solutions.

"Minkowski, for an arithmetic purpose, has developed one of them where all the circles are curves similar to each other in the ordinary sense of the word. Hilbert, from 1894, had given another of them which may be thus characterized: We consider a connected closed curve which will serve as fundamental curve. Let D be a straight, M a point of this straight; all the circles which have their center on D and which pass through M have the same tangent T, and this tangent, when the point M describes the straight D, pivots around a fixed point which is the intersection of two tangents to C at the points where this curve is cut by the straight D.

"Finally Hamel has in his thesis given the general solution of the question, but this solution is too complicated to be expounded in few words.

"I arrive at an important memoir of Hilbert's which is entitled 'Grundlagen der Geometrie,' which bears, consequently, the same title as his 'Festschrift,' but where, however, he places himself at a point of view altogether different.

"In his 'Festschrift,' in fact, as one sees by the preceding analysis, the relations between the notion of space and the notion of group, as they result from the works of Lie, are left to one side or relegated to a secondary part. The general properties of groups do not appear in the list of his fundamental axioms.

"This is not so in the memoir of which we are about to speak. Hilbert assumes a plane about which he makes the following hypotheses:

"1. The points of this plane correspond one to one to the points of the ordinary plane or to a part of these points. Thus each point of the new plane has its correspondent in the ordinary plane; but there may be on the ordinary plane points which have no correspondent on the new plane.

"The new plane has, therefore, so to say, less points than the ordinary plane, which is the contrary of that which happened for the non-Archimedean plane. The points of the ordinary plane which have correspondents on the new plane are called Bildpunkte. The ensemble of Bildpunkte forms on the ordinary plane a region which Hilbert assumes continuous and connected in such fashion that around each point of this region one can describe a circle of radius sufficiently small to be contained in this region and that one can go from one point to the other of the region, in follow-

ing a continuous curve and without going out from the region.

"2. The points of this new plane are susceptible of transformations called *movement* and which form a *group*.

"3. Among these movements, there are an infinity which leave fixed a certain point M and which are called rotations about M.

"The ensemble of the transformés of the same point A by all these rotations is called a circle. Every circle has an infinity of points.

"4. The group of movements forms a *closed system;* which means this: if there are an infinity of movements which change two points A_0 and B_0 the first into A_1 and B_1, the second into A_2 and B_2, $\cdots$ the nth into A_n and B_n; and if the point A_n tends towards A and the point B_n towards B when n increases indefinitely, there will also be in the group a movement which will exactly change A_0 into A and B_0 into B; and the same holds if in place of two points we consider three of them or only one.

"I have slightly abridged the statements, making them lose, it is true, a little of their precision, but without taking away anything essential. About these enunciations I have certain observations to make.

"The question in brief is to find all the groups of transformations of the plane into itself, or of a part of the plane into itself, these groups being subjected only to conditions in appearance very slightly restrictive. How, therefore, can one arrive at conclusions so precise?

"This results from the definition which Hilbert gives of movement. To be a movement, a transformation must satisfy many conditions; first it must be continuous and transform two points infinitely near into two points infinitely near; then it must be biuniform, that is to say, that every point of the plane must have one transformé and only one, and be the transformé of one point and of only one.

"By that are found to be excluded a very great number of groups; for example, the group of the projective transformations of the plane and the group of homothetics, that is to say, transformations which change every plane figure into a homothetic figure [a figure similar and similarly placed].

"Why? If we take, for example, the homothetic group we see that it contains degenerescent transformations, those where, the center of homothety moreover being any whatever, the ratio of homothety is nul or infinite. In these transformations the center of homothety has an infinity of transformés or is the transformé of an infinity of points. These degenerescent transformations, without which the group would not be a *closed system,* can not be excluded, nor any more can they be retained, since they do not satisfy the definition of movement.

"One may see in the same manner that a circle can not contain all the points of the plane, otherwise, among the rotations about the center of this circle, there would be one which would bring to the center a point of the plane, other than the center, so that the center would be the transformé of two points, of this point and of itself.

"That implies the existence of an invariant analogous to distance.

"One sees that the conditions are more restrictive than they seemed. In relation to the ideas of Lie, the progress realized is considerable. Lie supposed that his groups were defined by analytic equations.

"The hypotheses of Hilbert are much more general.

"Without doubt this is not yet entirely satisfactory, since if the *form* of the group is supposed any whatsoever, its *matter,* that is to say, the plane which undergoes the transformations, is still obliged to be a

Zahlenmannigfaltigkeit in the sense of Lie. This is, nevertheless, a step in advance, and besides Hilbert analyzes better than any one had done it before him the idea of Zahlenmannigfaltigkeit, and gives hints which may become the germ of an axiomatic theory of analysis situs.

"I can here only summarize the general march of Hilbert's ideas.

"He shows first that the points of a circle can be arranged in a determined circular order and that this order is not altered by rotations; then he shows that this order falls into the same *type of order* as the corresponding order of the ordinary circle, that is to say, into the type of the continuous. Thence he deduces this consequence that the circle is a continuous closed curve, because it must correspond point for point to the ordinary circle.

"One sees then that if a rotation does not displace one point of a circle, it will not displace any other point of this circle. Thence one can deduce that if a rotation does not displace one point different from its center, it will not displace any of the points of the plane and will reduce to identity. From this results finally that the group of rotations around a point M has the same structure as the group of ordinary rotations.

"One sees at the same time that there is no movement which leaves fixed two points of the plane, and that we can pass by rotations from one point of the plane to any other point whatsoever of the plane.

"All these demonstrations are extremely delicate; they require the repeated employment of the theorems of Cantor.

"This is to say that they are perforce very long and that the goal which one perceives immediately and which one thinks to touch can be attained only by long efforts.

"The greatest step is then accomplished; now we know that our group derives from certain subgroups, those of rotations, of which we know the structure, and this structure makes these subgroups fall into the category of Lie's continuous groups.

"We have, therefore, only a few difficulties still to vanquish, but Hilbert wishes first to define the straight and he has done it in a very original fashion.

"He rejects first the projective definitions of the straight which require considerations foreign to his premises. On the other hand, his geometry is a *plane geometry*.

"If we may use space of three dimensions, the theory of groups leads us naturally to a very simple definition of the straight, considered as axis of rotation; but here we can not use this, since we can not go out of the plane.

"Hilbert follows wholly another way. Let there be two points, A and B; define the middle of these points, that is to say the center of a rotation which changes A into B and B into A. Hilbert begins by demonstrating that two points have always a middle and have only one. It is here that comes in an hypothesis which above must have astonished the reader; we have supposed that the last axiom (which one states in an abridged fashion in saying that the group of movements is a closed system) is applicable not only if one envisages two points A_0 and B_0, but also if we consider three points. We have, therefore, made an hypothesis more restrictive than if we had limited ourselves to the consideration of two points A_0 and B_0. Was this restriction really necessary?

"It is in this part of the theory that it plays its rôle. We consider an infinity of points $B_1, B_2, \cdots B_n$, and the middles $M_1, M_2, \cdots M_n, \cdots$ of the sects $AB_1, AB_2, \cdots AB_n$; when n increases indefinitely, B_n tends toward B and M_n toward M and we make use of the hypothesis in question to show that M is the middle of AB. Had

it been impossible to use it, we could have been sure of this only after having constructed a special pseudogeometry.

"As it is, two points A and B being given, Hilbert constructs the middle of the sect AB, then the middle of the two sects MA and MB and so on. He thus obtains an infinity of points which form an ensemble E; he considers the derivative of this ensemble E, that is to say the assemblage of the limiting-points of E, points such that in any interval containing one there are an infinity of points of E. He shows that this derivative is a continuous line, and it is this line that he calls the straight [die wahre Gerade].

"The fundamental principles of the ordinary Euclidean or non-Euclidean geometry may then be easily established and in particular the metric axioms.

"It is impossible not to be struck by the contrast between the point of view where Hilbert places himself here and that which he had adopted in his 'Festschrift.' In this 'Festschrift' the axioms of continuity occupy the last rank and the grand affair was to know what geometry became when one threw them aside. Here on the contrary it is continuity which is the point of departure and Hilbert is especially preoccupied to see what one gets from continuity alone, joined to the notion of the group.

"It remains for us to speak of a memoir entitled 'Flächen von konstanter Krümmung.'

"It is known that Beltrami has shown that there are in ordinary space surfaces which are the image of the Lobachevskian plane, namely the surfaces of constant negative curvature; we know what an impulse this discovery gave to the non-Euclidean geometry. But is it possible to represent the whole entire Lobachevskian plane on a surface of Beltrami without singular point?

"Hilbert demonstrates that it is not; he founds his proof on the following theorems relative to the Beltrami surfaces.

"A quadrilateral formed of asymptotic lines has its opposite sides equal.

"The surface of a polygon formed of asymptotic lines is proportional to the spherical excess and it is the same with the surface of a polygon formed of geodesic lines; only in the first case the spherical excess is positive, in the second case it is negative.

"The author shows then that on a Beltrami surface without singular point one can not trace a closed asymptotic line; that an asymptotic line can neither cut itself, nor cut another asymptotic line in more than one point. Every other hypothesis would lead to polygons of which the spherical excess would be nul. Thence it follows as a consequence that if such a surface corresponds point for point to the non-Euclidean plane, this correspondence must be biuniform. But then in evaluating the total surface starting from the area of the polygon formed of asymptotic lines or from the area of the geodesic polygon we find in the first case that this total surface is finite, in the second that it is infinite. This contradiction demonstrates the theorem enunciated.

"In that which concerns the surfaces of positive constant curvature, to which the geometry of Riemann corresponds, Hilbert demonstrates that aside from the sphere there is no other closed surface of this sort. In fact, if we consider a portion of surface of constant positive curvature, the maximum of the great radius of curvature can not be attained *in the interior* of this portion, but only on its contour. This is a proposition entirely analogous to a well-known theorem relative to the potential.

"It follows thence immediately that if the surface is closed, the maximum can be nowhere attained and the radius of curva-

ture is constant. Thus we easily come back again to the sphere.

"After this analysis, all commentary is useless. One sees at how many different points of view Hilbert has placed himself, how profound is his analysis.

"His works mark an epoch and he seems entirely worthy of the Lobachevski prize. —Poincaré."

The 'Report on the works of Monsieur Barbarin, professor of higher mathematics at the Lyceum of Bordeaux, relative to the non-Euclidean geometry,' is by Professor Mansion, of Ghent, as follows:

"I. *List of the Works of M. Barbarin.* —M. Barbarin has published, from 1898 to 1902, the following memoirs and works relative to the non-Euclidean geometry.

"1. Géométrie générale des espaces (*Association française pour l'avancement des sciences.* Congrès de Nantes, 1898, pp. 111–132).

"2. Propriétés angulaires des cercles focaux dans les coniques (*Ibid.,* 1898, pp. 132–139).

"3. Constructions spheriques à la règle et au compas (*Mathesis,* 1899, pp. 57–60; 81–85).

"4. Etudes de géométrie analytique non-euclidienne (*Mémoires courounnés et autres Mémoires* publiés par l'Académie royale de Belgique, 1900, t. LX., 167 pp. in 8°. This memoir was presented to the Royal Academy of Belgium, the fourth of December, 1897).

"5. Le cinquième livre de la Métagéométrie (*Mathesis,* 1901, pp. 177–191).

"6. Les cosegments et les volumes en géométrie non euclidienne (Extrait des mémoires de Bordeaux, 1901; 20 pp. in 8°).

"7. La géométrie non euclidienne. Paris, Naud, February, 1902 (collection *scientia,* 79 pp. in 12°).

"8. Bilatères et trilatères en Métagéométrie (Mathesis, 1902, pp. 187–193).

"9. Polygones réguliers sphériques et non euclidiens (*Le Matematiche pure ed applicate,* 1902, t. II., pp. 137–145).

"We will now analyse these works, classing the results found by M. Barbarin under three heads:

"*Elementary geometry, conics and quadrics, infinitesimal geometry.*

"II. *Elementary geometry.*—In his little book entitled 'The non-Euclidean geometry' (List No. 7), M. Barbarin expounds the first principles of the geometry, especially after Saccheri, Bolyai and Lobachevski and, among the moderns, DeTilly, Gérard, Mansion. But, besides, he makes known, whether in this little book or in divers special notes, results which are his own.

"1. *Bilaterals and trilaterals* (List No. 8).—The author proves in an elementary manner, *without recourse to analysis,* that the locus of points equidistant from two straights is a straight; that the bisectors, the medians and the altitudes of a trilateral are copunctal (meet in the same point) [real at a finite or infinite distance, or ideal], even if the vertices of the trilateral are all or in part reals at infinity or ideals.

"He deduces from the theorem on the three altitudes a novel construction of the normal common to two Lobachevskian straights which only meet at an ideal point.

"2. *Fundamental constructions* (List No. 3, No. 4, § I., pp. 5–14; No. 7, pp. 46–49).—M. Barbarin gives the means of constructing, with the ruler and the compasses, a right-angled triangle or a trirectangular quadrilateral given two elements and thence deduces all the fundamental constructions of the non-Euclidean geometry.

"He depends, in these constructions, on the old theorems of Lobachevski and Bolyai and on three new theorems which seem to have escaped these illustrious geometers. Here they are, in Lobachevskian geometry:

"Let $ABCD$ be a quadrilateral trirect-

angular in B, C, D, and having, consequently, angle DAB acute; E — a point situated between D and A, F — a point situated between B and A, such that $CE = BA$, $CF = DA$.

"We have (1) $BF = DE$. (2) CE is asymptote (Lobachevskian parallel) to BA, CF to DA. (3) The perpendiculars let fall on CB, CD from points equidistant from C taken on CE, CF intersect on the diagonal CA.

"3. *Regular spheric and non-Euclidean polygons* (List No. 9.—M. Barbarin has found constructions simple and novel for the regular polygons of 3, 6, 5, 10, 15 sides, applicable at the same time in Euclidean geometry and in non-Euclidean geometry of Riemann and of Lobachevski, *for the sphere and for the plane.*

"4. *The fifth book of Metageometry* (List No. 4, ch. IV., pp. 94–99, No. 5, No. 7, pp. 37–41).—M. Barbarin calls fifth book of 'Metageometry' that which corresponds to the fifth book of the 'Elements of Legendre' or to the eleventh of Euclid.

"He makes an elementary exposition of it more complete than does any of his predecessors; here and there it could have been intuitive if he had depended more on the asymptotic property of Lobachevskian parallels. There is room to cite in this work the two following theorems: (1) That a right angle may be projected upon a plane into a right angle, it is necessary and sufficient that the projector of the vertex be normal to the plane and to one of the sides of the angle.

"(2) Two Riemannean straights not situated in the same plane have two common normals; if these normals are equal, the two straights are equidistant.

"Descriptive non-Euclidean geometry rests on the first proposition.

"From the second, it results that there exist, in Riemannean geometry, skew squares and rectangles having four right angles and surfaces equidistant from a straight with rectilinear generators.

"5. *Coordinates; geometry of n dimensions* (List No. 1, No. 4, § II., pp. 14–28, § IV., pp. 84–101).—In his 'Studies in non-Euclidean Analytic Geometry,' M. Barbarin has been led to certain new developments of the theory of coordinates, and, consequently, to expound by the calculus, the fundamental properties of the straight and of the plane, of angles and of distances, of the circle and of the sphere.

"This is, in the main, under analytic form, the complement of his other studies on the 'Elements.'

"The memoir of pure analysis, entitled 'General Geometry of Spaces' is a generalization of the formulas of Euclidean or non-Euclidean geometry of three dimensions relatively to the straight, to the plane, to the triangle and to the trihedrals and the trigonometric relations relative to them, when one considers a variety of n dimensions. The author shows, in particular, that for such varieties there exists also a limit-case that we may call *Euclidean geometry of n dimensions.*

"III. *Conics and quadrics* (List No. 2, No. 4; the essential part of 2 is reproduced in 4). The 'Studies in non-Euclidean Analytic Geometry' constitute M. Barbarin's largest work. It is devoted, for the major part (§ III., pp. 29–84; § V., pp. 101–139), to a classification of conics and quadrics more complete than that of his predecessors, without having any recourse to the Cayleyan geometry.

"A. *Conics.*—The author first reduces to its most simple forms the general equation of the second degree or rather a ternary quadratic form.

"In Riemannean geometry he finds only two kinds of curves: *imaginary conic* and *ellipse*, the latter having the *circle* as variety.

"The Lobachevskian geometry is much

richer in curves of the second degree. The curves with real center are the *ellipse* (real, semi-real, ideal or imaginary) with the important varieties, *circle* and *hypercycle* (= equidistant from the straight). The curves denuded of center, even at infinity are the parabolas (elliptic, veritable, hyperbolic). The curves with center situated at infinity are the *oriconics* (oriellipse, with the variety oricycle of Lobachevski, orihyperbola).

"M. Barbarin generates the lines of the second degree by homography and by movements of linkages; he investigates their foci, their focal circles and their directrices; finally their reciprocal curves. Two reciprocal curves of the second degree are such that each is the locus of the center (real or ideal) of the tangents of the other. The properties of these curves are a consequence of the principle of duality, which is, so to say, evident in non-Euclidean geometry.

"The author then studies the plane sections of a cylinder or of a cone of the second degree (that is to say, having for plane directrix a curve of the second degree); he finds again in this way all the varieties of curves of the second degree, which are, therefore, truly conics. He extends to non-Euclidean conics the most celebrated theorems relative to Euclidean conics and, in particular, those of Dandelin. He obtains in a manner more systematic still all the curves of the second degree, Riemannean, Euclidean, Lobachevskian, by cutting the cone of the second degree by a concentric sphere, the common center being real, at finite or infinite distance, or ideal.

"One again finds conics in cutting by a plane the straight equidistant surface (tube of revolution with rectilinear axis, or hypercycloide of revolution). In Riemannean geometry there is a case where one finds as section two straights equidistant from the axis, but not coplanar with the axis (compare above, II., 5): these straights are the *helices* of this surface.

"B. *Quadrics.*—The reduction of the general equation of the surfaces of the second degree is deduced from the discussion of the equation in s of the nth degree.

"In Riemannean space, we find two principal species—*ellipsoid* (with the varieties ellipsoid of revolution, tube sphere), *pipe-hyperboloid* (with the varieties cone, hyperboloid of revolution or elliptic tube, two planes).

"In Lobachevskian space we find first the species *ellipsoid* (with three unequal real axes, semi-real with two real axes, with one real axis or imaginary); the *first hyperboloid* (with one nappe real, with two nappes real, with one nappe ideal); the *second hyperboloid* (with two nappes real or ideal). The varieties or limits of these three species are very numerous. All these surfaces have a center and three principal planes.

"The *paraboloids* (elliptic, semi-elliptic or hyperbolic) and their numerous varieties have no center and have two principal planes. They *cut* the sphere of infinite radius.

"At the limit, when they become *tangent* to this sphere, they are transformed into oriquadrics (oriellipsoid, orihyperboloid) and into their varieties.

"M. Barbarin has studied the rectilinear and circular sections of these surfaces, their focal spheres and their directrices.

"IV. *Infinitesimal geometry.* 1. *Measure of areas and of volumes* (List No. 4, pp. 164–167; No. 6; No. 7, pp. 50–59).—M. Barbarin in his little book, 'The non-Euclidean Geometry,' summarizes in some pages the results found by Lambert, Lobachevski, Simon, etc.; but he calls attention also (List No. 6) to an original idea of which he is the author. He has remarked that the volume of a frustum of a non-Euclidean cone of revolution is propor-

tional to the difference between the projection of the generatrix on the axis and this generatrix multiplied by the cosine of the angle which it makes with the axis if it meets it, or of the normal common to the generatrix and axis. He has thence deduced a *general formula for volumes decomposed into infinitesimal spindles of revolution.*

"By means of this formula he has been able to reach a number of known results; especially he has been able to make an advance in the very difficult question of the volume of the tetrahedron, which, as is known, has arrested Gauss, Bolyai and Lobachevski and all their successors.

"M. Barbarin finds an expression for the volume of the tetrahedron *where are introduced naturally the products of the edges by the corresponding dihedrals.* To achieve the solution of the question, it is requisite to find, under a finite form, certain functions relative to the faces which present themselves in the calculations under the form of integrals or complicated series.

"2. *Geodesic lines of tubes and pseudospheres* (List, No. 4, pp. 139–164).—In the last section of his 'Studies in non-Euclidean Analytic Geometry' the author has reached one of the most beautiful theorems of metageometry.

"It has been known, since Lobachevski and Bolyai, that the characteristic geometry of orispheres is Euclidean; since Beltrami, that of the Euclidean pseudosphere is Lobachevskian; finally it is evident that that of the sphere is Riemannean.

"The theorem of Barbarin (it is to be hoped that it will retain this name) comprises and generalizes in the most unexpected manner these particular propositions. Here it is in its most condensed form: *Each of the three spaces, Euclidean, Lobachevskian, Riemannean, contains surfaces of constant curvature of which the geodesic lines have the metric properties of the straights of the three spaces.*

"These surfaces are the spheres (characteristic geometry, Riemannean); the tubes or surfaces equidistant from a straight, it being possible for the distance to be infinite, which gives the orispheres (characteristic geometry, Euclidean); finally the pseudospheres, that is to say the surfaces of revolution which have for meridians a tractrix or line of equal tangents (characteristic geometry, Lobachevskian).

"The property of the surfaces equidistant from a straight is almost evident and has been found also by Whitehead; but the existence of Lobachevskian tractrices and pseudospheres and above all of Riemannean and the properties of their geodesics were not suspected before M. Barbarin.

"The curvature of the pseudospheres is negative in Riemannean space as in Euclidean space; it is negative, nul or positive in Lobachevskian space.

"V. *Résumé and Conclusion.*—Non-Euclidean geometry owes to M. Barbarin (1) fundamental properties of the plane trirectangular quadrilateral; (2) the discovery of Riemannean equidistant straights; (3) the complete classification of non-Euclidean conics and quadrics; (4) the most intuitive formula that we know for the determination of volumes, with a remarkable application to the tetrahedron; (5) finally and above all the beautiful general theorem cited above on the geodesics of tubes and pseudospheres, in the three geometries.

"All these results have been obtained by the direct study of the figures without borrowing anything from the Cayleyan geometry.

"If Lobachevski should come back to the world, he would recognize in M. Barbarin

a worthy continuer of his work, inspired with his ideas and his method.

"We believe, therefore, that the Physico-mathematic Society of Kazan may legitimately decree to him the Lobachevski prize. —P. Mansion."

To Professor Hilbert I am particularly, personally indebted. My 'Rational Geometry' is an attempt to give every teacher, every scholar the benefit of coming after him, the priceless advantage of living since the outpouring of his genius.

Monsieur Barbarin has honored me with his genial friendship.

I suppress the temptation to institute comparisons or discuss a decision.

GEORGE BRUCE HALSTED,
Membre d'honneur du Comité Lobatchefsky.

THE TROPHOBLAST: A REJOINDER.

THE name *Trophoblast* was used for the first time by me in the meeting of the Anatomical Congress at Würzburg in 1888, and its earliest definition is found in the report of that meeting in Nos. 17 and 18 of the *Anatomischer Anzeiger*, Bd. III. We there read, concerning a very early stage of the hedgehog (p. 510):

"Die äussere Wand der Keimblase ist verdickt (drei bis vierschichtig) und besitzt wabige Lacunen. Für diese äussere (epiblastische) Schicht sei der Name *Trophoblast* gewählt."

In a footnote we find in addition (p. 511):

"Es ist meiner Ansicht nach zweckmässig, sich bei der Säugethier-embryologie diesen Namen zu wählen, um damit den nicht zum Aufbau des Embryos verwendet werdenden Epiblast anzudeuten * * *."

It is evident from the citations here given that the names outer epiblastic wall of the mammalian blastocyst and trophoblast are synonyms. Later researches have been directed towards the question how in other mammals than the hedgehog the separation between the epiblast of the embryonic shield, *i. e.*, the formative epiblast and the trophoblast, comes about.

In the same Bd. III. of the *Anatomischer Anzeiger*, on p. 907, mention is again made of the hedgehog's 'geschlossene Trophoblastblase (wie ich den primären Epiblast, von dem sich durch Abspaltung der Epiblast des Fruchthofes nach innen abhebt, zu benennen vorschlug).'

Again, in the article on the placentation of *Erinaceus* in Vol. 30, Pt. 3 (1889), of the *Quart. Journ. of Microsc. Science*, where the definition was reproduced, it is insisted upon (p. 298) that "the use of the name trophoblast will render unnecessary such circumlocutory expressions as 'outer epiblastic layer of the blastocyst,' 'primitive exochorion,' etc." Further argumentation on p. 299, in which the allantoidean and the omphaloidean trophoblast is defined, leaves not the faintest doubt as to what the name *trophoblast* has originally stood for.

Five years later (1894), in an article, 'Spolia nemoris,' which appeared in Vol. 36 of the *Quart. Journ. of Micr. Science*, I again insisted (p. 111) that 'new and valid reasons are thus accumulated for designating the outer layer of precociously segregated epiblast cells that form the wall of this vesicle [the early mammalian blastocyst] by a separate name, [for which] I have proposed the name of trophoblast.' Somewhat further is added (p. 112): 'in *Tupaja* and *Tarsius* portions of the trophoblast undergo very active proliferating processes preparatory to the placentary fixation of the blastocyst, whereas in my former papers I have described the same activity for *Erinaceus* and *Sorex*.'

Finally, in 1895 (*Verhandl. der Kon. Akad. v. Wetenschappen te Amsterdam*, Vol. IV., No. 5, p. 18), I reaffirm that:

'die von mir Trophoblast genannte Keimschicht ist * * * die äussere schicht der Säugethierkeimblase welche vor der definitiven Ausbildung des formativen Epiblastes dieses sowie die Hypoblastanlage umhüllt und an der Bildung des Embryos überhaupt keinen Antheil nimmt.'

In this last paper I have for the first time asserted that in my opinion the Sauropsidan arrangement, as well as that of the Ornithodelphia, can not possibly be looked upon as ancestral to what we find in the monodelphic (and didelphic) mammalia and that, on the contrary, the trophoblast (*l. c.*, p. 57, No. 7) is a precociously segregated larval envelope which encloses an inner cell mass, out of which the embryo is going to be built up. I have at the same time drawn a comparison between the mammalian trophoblast and the 'Deckschicht' in amphibian development and have also drawn attention to those cases where remnants of a trophoblastic layer could be detected in the Sauropsida.

Only in 1902, however, have I gone yet further back, and leaving the recent amphibia out of the ancestral line, I have attempted to draw a comparison between the trophoblast (and the other fœtal membranes coexistent with it) of the Amniota and larval envelopes of invertebrate predecessors (*Verhandl. der Kon. Akad. v. Wetenschappen te Amsterdam*, Vol. VIII., No. 6, 1902, p. 53). Alinea! 'It has now been shown that since the first introduction of the name *trophoblast* sixteen years ago my own definition and interpretation of it has not undergone any alteration, although advances have been made in the appreciation of its theoretical significance.

And it is for this reason difficult for me to understand that the name has been misunderstood both by embryologists and by gynæcologists, even to such an extent that the writing of the present article seems necessary to prevent further confusion.

So, for example, Charles S. Minot's definition of the trophoblast on p. 100 of his 'Laboratory Text-book of Embryology' (1903) as 'a special layer of cells developed on the outer surface of the ectoderm of the mammalian blastodermic vesicle' is both wrong and misleading. Several statements in the same paragraph on p. 107, *e. g.*, that the trophoblast is sometimes developed only later; that it disappears when the placenta is being formed, etc., are likewise in complete disaccordance with the original definition, such as it was substantiated by the different quotations given above.

In attempting to explain for myself how Minot can have fallen into this error—from which consultation of the papers above quoted would have withheld him—I can not but suppose that Bonnet's 'Grundriss der Entwickelung der Haussäugethiere' must have led him astray. In this we find on p. 31 a woodcut (Fig. 17), in which the trophoblast (Bonnet's primärer Ectoblast) is represented as a separate layer outside of the ectoderm of the monodermic blastocyst of the hedgehog and which woodcut is marked 'nach Hubrecht,' although I never published anything of the kind, nor in my writings have ever, as we have seen above, given the slightest justification to an interpretation so entirely inconsistent with my own views which have repeatedly been expressed without any ambiguity. Already on p. 19 of my paper of 1895* have I called attention to the fact that Bonnet's woodcut was a misrepresentation of my own views and have on Plate IV., Fig. 81, reproduced a hardly known figure of Kölliker's of the rabbit's blastocyst, which, on the contrary, is in complete accordance with those views. Misrepresentations, however, are hard to kill.

In Hertwig's 'Handbuch der vergl. Ent-

* *Verhandel. Kon. Akad. Amsterdam*, Vol. IV., No. 5.

wickelungslehre der Wirbelthiere' (Bd. I., S. 917) and in Weber's 'Säugethiere' (S. 284) similar transpositions of my intentions in insisting on the recognition of a distinct trophoblast have not crept in. I cite from Hertwig:

"Die verschiedene Entwickelung der Trophoblastes hat Hubrecht in folgenden Sätzen kurz zusammengefasst." "Die von mir Trophoblast genannte Kiemschicht ist für die Anheftung des Säugethierkeimes an die mütterlichen Gewebe in erster Linie bestimmt: dabei entwickeln sich zu gleicher Zeit in der mannigfaltigsten Weise lokalisierte oder über die ganze Oberfläche sich orstreckende Wucherungen, welche zur Ernährung des Embryos dienen." "Der definitive formative Epiblast welcher als sogenannte Keimscheibe oder Embryonalschild auf der oberen Fläche der Keimblase hervortritt, ist zur Zeit seines ersten Auftretens nie an der Oberfläche gelegen, sondern immer von Trophoblastzellen überlagert.

"Die Art und Weisè wie diese Ueberlagerung des formativen Epiblastes durch Trophoblastzellen ein Ende nimmt, ist sehr verschieden; entweder entsteht zwischen Epiblast und Trophoblast ein persistierender Raum, welcher etwas später zur Amnionhöhle wird (*Erinaceus, Arvicola*), oder es tritt eine engere Verwachsung von den Epiblastrandern mit dem Trophoblast ein, worauf ein Durchbruch der deckenden Trophoblastzellen erfolgt, welche letztere später zu Grunde gehen (*Tupaja,* Maulwurf, vielleicht auch Fledermaus und Schwein) oder endlich, es wird die trophoblastische Deckschicht oberhalb der Keimscheibe sehr erheblich abgeflecht, wodurch der formative Epiblast und der Trophoblast dem Anschein nach in engstem genetischem Verbande stehen, während in Wirklichkeit der Verband zwischen dem peripheren Bezirk des Trophoblastes und seinem als Deckzellenschicht zu bezeichnenden Abschnitt auch hier die primäre, die anfänglich kontinuierliche Verbindungsweise gewesen ist (*Lepus, Sorex.*)" "Der Entwickelungsgang kann eine Abkürzung erfahren, indem die Amnionhöhle innerhalb eines vom Trophoblast verfrüht abgetrennten Epiblastzellenkörpers spontan erscheint (*Cavia, Pteropus*)."

I hope that these quotations may dispel eventual doubts about the significance of the term trophoblast.

I have now to consider the application of that term in gynæcology, more especially its application to the placentation of man and of other mammals. I find that its use has become more general with English and American than with German authors, and at the same time it would seem as if also in this case a tendency to misunderstand the real significance of the term has sprung up.

This tendency is very naturally explained when we consider how important a factor for the process of placentation the proliferation of trophoblast cells has been shown to be. This proliferation is especially very luxurious in man (Siegenbeek van Heukelom, Peters) in the hedgehog (Hubrecht), whereas in many other insectivora and rodents its multiform complications are exceedingly varied. In consequence many investigators have been led to believe that the name trophoblast was originally restricted to those proliferating regions, whereas we have demonstrated above that this has never been so. Add to this that the proliferation of cells contributing to the formation of the placenta yet in another way is apt to lead to confusion because such proliferation is in no way limited to embryonic cells, but is also noticed—sometimes to a more considerable extent—in maternal cells belonging to the epithelial lining of the uterus or to the subepithelial maternal tissues. In this way debates have arisen between Strahl and

Lüsebrink on one side and Duval, van Beneden and myself on the other, of which debates the object was to make out in how far the material of the proliferating placenta should be looked upon as maternal and in how far as embryonic, trophoblastic tissue.

These debates will no doubt, in the course of time, as the number of carefully observed cases increases, lead to a unanimous interpretation. As it was, I have myself, for sheer diffidence of attributing too prominent a part to trophoblastic proliferation (of which I was, nevertheless, together with Duval, the first advocate), in one case stopped short of the real solution, and have for the hedgehog restricted the extent of the trophoblast more than was necessary. Since then I have corrected this in a doctor dissertation of one of my pupils (Resink, 1903), but there is no doubt that I am myself thus responsible for a certain amount of vagueness and misrepresentation which has prevailed in the application of the term trophoblast to different placentas, more particularly of man and the monkeys, where the question arose in how far certain syncytial tissues should be looked upon as maternal or as embryonic. Even for pathological anatomy this proved to be a momentous question in so far as the deciduoma malignum, if traced to remains of trophoblast cells, would be very different from other deciduomæ, that found their origin in maternal tissue.

Now that the placentation of *Tarsius, Tupaja, Sorex, Vespertilio, Cercocebus, Talpa, Galeopithecus, Sciurus, Lepus,* a. o., has been more carefully examined (trophoblastic proliferation having been figured by Selenka as early as 1887, for one of the Didelphia [*Opossum*]), divergence of opinion will in a few years hence have been replaced by unanimity also on this head.

And then the application of the name trophoblast to those placental elements that arise from the embryonic layer originally designated by that name will be in no way confusing, but will, on the contrary, contribute to keep before our eyes the intimate relation between the facts as they take place under our eyes and their phylogenetic origin.

With perfect justification Strahl has protested (Hertwig's 'Handbuch der Entwickelungslehre der Wirbelthiere,' I., 2, p. 311) against a misapplication of the terminology, which I have attempted once more to explain in this article, when authors who have insufficiently studied the subject even go so far as to speak of a *maternal* trophoblast beside the embryonic!

I hope that this paper may henceforth render misinterpretations such as are discussed in it impossible.

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SCIENTIFIC BOOKS.

Geographic Influences in American History. By Albert Perry Brigham, Professor of Geology in Colgate University. Boston, Ginn & Co. 1903. Pp. 365.

Professor Albert Perry Brigham, of Colgate University, has made a notable contribution to American geographical literature in his book, 'Geographic Influences in American History,' published by Ginn and Co. The divisions of the book are mainly physiographic, but the author has not allowed this subject undue prominence.

Chapter one is entitled 'The Eastern Gateway of the United States.' The central idea is the development and importance of the Hudson-Mohawk valley—its physiographic origin and its influence upon American history. Its importance in the Revolution and the war of 1812, and the successive waves of immigration which passed through it and left their record in the 'successive layers of geographic names' are well brought out. The interdependence of the valley and the cities which have grown up along it and the conditions of growth of the metropolis at its mouth are discussed.

'Shore Line and Hill Top in New England' is the title of chapter two. A mountain foundation covered with drift is described as the physiographic type of the division. The influence of this structure upon life, upon agriculture and the diversion of the streams, thus causing the waterfalls so prolific of power, the resulting coast line and its result upon commerce are among the topics taken up. The history of New England, which has been directed to some extent by surface and climate, is discussed, but the author does not lose his balance. 'That environment influences character,' he says in summing up the influences of climate and physical features, 'need not be asserted; but one can not be sure in weighing its influences.' The coloring of the literature of New England by geographic influences is shown by selections from Emerson, Whittier and Thoreau.

The 'Appalachian Barrier' is discussed in the third chapter. The region of mountains, plateau and valley which stretches as a unit from New York to Alabama, together with its fringe of Piedmont Plateau and coastal plain, is described in popular language. The unity that such a barrier enforced upon the colonists and its effects upon the Revolution are the principal themes of the chapter. The development of routes across this barrier, first by trails and later by railroads, is described.

Chapter four has the title, 'The Great Lakes and American Commerce.' The Great Lakes, their probable origin, their geographical features and their historical and industrial influences are prominent topics. Duluth, Milwaukee, Chicago, Cleveland and Buffalo are accounted for on geographic principles. Niagara, past, present and future, is discussed. In discussing this great continental waterway from Buffalo to Duluth the fact, perhaps not generally appreciated, is emphasized that more tonnage passes through the 'Soo' than through the Suez canal, and that the commerce of Cleveland at times rivals that of Liverpool.

Chapter five deals with the prairie states, taking Illinois and Iowa as types. The introductory pages describe the visit of the Spaniard on the south and the invasion of the French trapper and trader on the north. In following the latter an idea is given of the drainage systems which provided paths for them. The topography of Ohio, Indiana and Illinois is contrasted with that of New England. Both are glaciated regions, but the former has received the ice action on a fairly level surface, so that the glacial detritus is more evenly spread, the finer materials of ice action have not been swept away and the level, fertile prairies are the result. The author takes up the settlement of this district, the routes of immigration, the development of its social and financial problems and the location and growth of its cities.

'Cotton, rice and cane' is the title of the chapter which deals with the group of southern states. The coastal plain with its level surface and sluggish tidal rivers is described as the typical structure of most of the states of this division. Virginia, North Carolina, Georgia and Alabama have in addition considerable area in the Piedmont Plateau, while Florida has a structure rather peculiar to itself. In South Carolina three zones of life and industry are described, each a good example of 'earth control.' Sea Island cotton, rice and truck farming are characteristic of the coast lowlands and islands. Here is the 'black belt.' Between this and the plateau is a belt of sandy country whose inhabitants, the 'sand hillers,' share the poverty of the soil. In the northwestern corner of the state is the plateau country whose poorer soil and cooler climate made slavery less profitable, and the whites are more numerous than the colored people.

North Carolina, while rich in land and with a genial climate, drew her population from Virginia and South Carolina. The sand reefs on the coast and lack of harbors cut her off from the sea. Florida is described as altogether coastal plain, and the most youthful of the states. The lack of water power and coal and the scarcity of most minerals would seem to justify the author's prophecy that the country will not give way to the town to the same extent as in most states.

The evolution of the plantation, the growth of the slave system and the present social and

industrial development are discussed from the standpoint of geographic principles.

The civil war is taken up from the author's standpoint in chapter seven. The rivers, mountains and topographic features that had a bearing on the conduct of the war are first considered. Then follows an analysis of the geographic influences upon the three great campaigns of the war: the opening of the Mississippi, the operations around Chattanooga and the Virginia campaign. Although, perhaps, a digression from the general plan of the book, this chapter is exceedingly interesting and indicates the possibilities of a line of research which has been strangely neglected by historians.

The arid regions of the west are described in chapter eight. After a discussion of the varied physiography of these regions and the causes which deny to them their share of rain, the author presents an interesting example of geographical politics.

During the early part of the decade from 1885 to 1895 there was a slight increase of rain in this region which coincided with the rush of settlers into western Kansas and Nebraska. Later the normal dry seasons followed and brought disaster. The people, pressed for ready money, accepted populistic doctrines and the movement grew out of 'the failure of a frontier population properly to adjust itself to geographic conditions.'

The problems of irrigation constitute a considerable portion of this and the succeeding chapter. The origin of irrigation, its possible effect upon society, its intensive agriculture, its present status and its regulation and distribution are well brought out. One leaves the subject with a lively impression of this problem which most of us not immediately concerned do not fully appreciate.

Chapter nine treats of the mountain and plateau states under the title, 'Mountain, Mine and Forest.' Colorado is described as the typical western state. After briefly treating of the physiography, the mining interests are taken up in some detail. The origin of veins and lodes, the influences of mine development upon society and the location and growth of Denver, Pueblo, Leadville and other towns are described. After describing their physiography, the problem of irrigation in Arizona, Wyoming, Idaho and Nebraska is discussed. The influence and preservation of forest reserves in these states are taken up.

'From the Golden Gate to Puget Sound' is the title of chapter ten. The three Pacific states are described as having a common backbone in the Sierras, a similar depression to the west of these and a common range fronting the sea. The geological development which produced the present surface and made possible the mineral wealth is discussed in a readable manner. To this land the Spaniard came, but his occupation gave only a 'sentimental background' to its history. The Mexican occupation left scarcely more impression; the Yankee traders bought their hides, took them to New England, carried them back and sold them as shoes in California ports. The author sketches the discovery of gold, the rush of the 'forty-niners' and the subsequent steps to the admission of California as a state. Coming down to 1900, it is interesting and significant to learn that the agricultural output of the state exceeds over threefold the value of its mineral product. The location of cities and the relation of the Isthmian Canal to the Pacific coast are among the topics considered.

Oregon and Washington are discussed together in history, topography and products. Their settlement against the efforts of the Hudson Bay Company is sketched. Their coal fields and forests are described and their commercial possibilties are prophesied in these words: 'He need be no seer who sees cities like those of the Atlantic standing under the western sun.'

The eleventh chapter deals with 'Geography and American Destiny.' The author finds in American history one geographic fact of overshadowing importance: 'A wide ocean separated an advanced civilization and a relatively dense population from a wide, rich and almost unoccupied continent.' The growth of the nation by conquest and purchase, its development along geographic lines and its advent into more active world relations in 1898 are described. The dominant topic of the chap-

ter is American unity. Intercommunication, common business interests and common national ideals are named as factors contributing to this unity.

The final chapter treats of 'Governmental Study of our Domain.' It contains a description of the work of the Geological Survey, Coast Survey, Fish Commission, Department of Agriculture and other departments of governmental activity.

'Geographic Influences' is almost a pioneer in its line. Among the geographic influences the author places the greatest emphasis upon physiography, but the treatment is not overbalanced. A quality which can hardly be shown in a review is the vigorous, attractive style. The author presents a wealth of facts without a trace of 'statistical' manner. The illustrations are well selected and several maps are included in the work. The book should have a good circulation among those readers who are interested in American history. It will also appeal strongly to an increasing number of students who are considering the relations of the earth sciences to the politico-historical sciences.

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DISCUSSION AND CORRESPONDENCE.

THE METRIC SYSTEM.

TO THE EDITOR OF SCIENCE: I feel that I must congratulate your readers on the review of 'The Metric Fallacy,' published in your issue for August 5, from the pen of Professor W. Le Conte Stevens. Passing by the charges of partisanship and intolerance for the moment, as of no real importance, the review exhibits a comprehension of the subject which is rare—I might almost say unique—among metric advocates. My purpose in writing this letter is to point out that Professor Stevens's admissions are of far greater importance than he seems to suspect, and I trust you will find a place for it—not as a reply to the review, nor as a defence of the book, but as a continuation of an important discussion.

As I have pointed out in a special chapter of 'The Metric Fallacy' (The Pro Metric Argument), the metric advocates have based their case upon the belief that the change to their system is an easy one. This belief is the chief burden of the pro-metric statements made before the house committee on coinage, weights and measures, of the fifty-seventh congress, and it was largely through its reiteration that the favorable report of that committee was obtained. In the above-named chapter will be found quotations from the statements made by a dozen metric advocates before that committee in which the longest period named for the change is five years. I can, however, ask you for space to repeat but one of these—the gem of the whole collection—which came from Lord Kelvin (italics mine):

> I believe that *in a fortnight* people would become so accustomed to the perfect simplicity and easy working of the metrical system, that they will feel that instead of its being a labor to pass from one system to the other, *it will be less than no labor.*

This opinion, I should add, was repeated with approval at the great discussion of the American Society of Mechanical Engineers in 1902.

Through a clipping bureau, I have received from Great Britain hundreds of newspaper clippings pertaining to this agitation in that country, and the case there, as here, is based upon this assumption.

It would, indeed, be superfluous to mention this contention of the metric advocates, except to point out that Professor Stevens is so far in advance of his associates as to frankly tell us that 'reasonably complete assimilation will take several generations' and that 'none of us of to-day will live to see anything better than good progress on the part of the general public in getting accustomed to the new standards and in losing devotion to the old ones.'

Among those whose opinions as to the shortness of the transition period are given in the chapter on 'The Pro Metric Argument,' are: Elihu Thompson, Harvey W. Wiley, S. W. Stratton, Simon Newcomb and Lord Kelvin. Professor Stevens seems to think I have not treated these opinions with due respect, but in view of the above quotations from his review it is hard to see wherein he respects them more than I do. He plainly regards

them as worthless and I can go no farther than that.

In view of the facts regarding the use of old units in all metric countries, how is it possible to treat with respect the repeated assertion of the metric advocates before the house committee on coinage, weights and measures that the change with us will require but from two to five years, and what matters it that these statements are made by men of distinction, chief of whom is Lord Kelvin?

Following the assumption of the ease of the change, and a necessary outgrowth of it, is the assumption that it has been made in countries in which the system has been adopted. Thus in 'The Coming of the Kilogram,' published by the English Decimal Association, and thus made official, we may find:

'There are now no longer a great number of sets of weights and measures in use among the civilized peoples of Europe; there are really for all useful purposes two only,' these being, of course, the English and the metric.

It would again be superfluous to mention this contention of the metric party, but for Professor Stevens's remarkable admission:

> A century has not been sufficient to cause the abolition of old names and units among the common people of France, resort to them being usual when no penalty is involved. The same is true in Germany and Switzerland and in every other country where the metric system is, in business transactions, either obligatory or permissive.

If it is the common experience that the people of metric countries resort to the old units when no penalty is involved, then it is clearly impossible to bring the system into common use in this country where general compulsion is admittedly impossible. Furthermore, if this system is so superior, how can this admission be true? Why should it be necessary to compel people to use such a wonderfully superior thing as the metric system is represented to be? It is certainly the only case of the kind on earth.

Just as the pro-metric case has been based upon the belief that the change will be short and easy, so the anti-metric case has been based upon the belief that, as shown by the experience of other countries, it would be long, difficult and costly, and that the long transition period would be one of great confusion. While I have made no count of its pages, it is safe to say that eighty per cent. of 'The Metric Fallacy' is devoted to enforcing this and to nothing else. Professor Stevens now comes to our assistance, however, and admits that a century of compulsory laws in France, and thirty years of them in Germany, have been insufficient to complete the change, that 'certain people would lose money and otherwise suffer much inconvenience from the change,' that 'all possible consideration should be accorded to those whose large pecuniary interests are affected' and that 'the first result will be not the abolition of confusion, but the increase of confusion,' and how long he expects this period of added confusion to be is shown by his admission that 'none of us of to-day will live to see anything better than good progress on the part of the general public in getting accustomed to the new standards and in losing devotion to the old ones.'

It thus seems to me that Professor Stevens has admitted pretty much all that we have contended for. There remain, in fact, but two important differences between us—he regards the change as worth this cost and this period of confusion, while Mr. Dale and I do not, and he regards the change as feasible, while, in a manufacturing sense, we regard it as impossible.

In common with other scientific men, Professor Stevens fails to recognize the root of the difficulty and of the opposition, the difficulty of changing established manufacturing standards, of which textile, screw thread and pipe standards are representative. I am, in fact, in this respect, disappointed in this review, as it ignores what I regard as the two most important chapters of my portion of the book 'Scientific and Industrial Measurements' and 'Scientific and Industrial Difficulties.' I have there pointed out—I believe for the first time and without reflection upon either party—the reason why scientific men favor the system while manufacturers oppose it. In brief, this is because 'the scientific use of measurements consists in measuring existing things; the industrial use of measurements

consists in making things to required sizes.' In scientific work the change involves a change in measuring instruments only, while in industrial work it involves a complete change in standardized manufactured goods—a change which manufacturers know to be impossible. I can not ask for space to enlarge upon this, but it explains completely the different attitudes of the two parties.

Mr. Dale and I profess to speak as those who are experienced in manufacturing, and as having given protracted study to the effect of this change upon manufacturing industry. As scientific men have, rightly, no respect for the opinions of the non-scientific upon scientific questions, so we have no respect for the opinions of those who have no expert knowledge of manufacturing upon the effect of this change upon manufacturing industry. We acknowledge that our language is harsh, but it is in no way more so than the stock dismissal of all objections to this change as due to 'ignorant prejudice,' and it is not for those who have always treated our views with contempt to object when they find their own non-expert views treated in the same manner. While Professor Stevens, although opposed to us, has been so generous as to frankly give recognition to our book by saying that it contains 'a mass of information that must be taken into account,' he should, and doubtless does, know that the chief weapons of the prometric party have been ridicule and contempt, and he should not criticize us for making use of the same guns. We believe that we are justified in using them when discussing opinions that entirely fail to recognize the importance, in many cases the existence, and in all the formidable nature of the difficulties that surround the manufacturing side of the question. What scientific men need to learn more than all else in connection with this subject is that their experience, their knowledge and their horizon do not include manufacturing. They have uniformly failed to recognize the difference, or, indeed, that there is a difference between measuring things and making things. They are measurers, not makers, and their opinions have no value and no application as related to manufacturing.

The proposition is that we make this change in industry and commerce. It is, therefore, an industrial and commercial, and not a scientific question. It is the province of scientific men to determine the weights and measures which they shall use, but when they endeavor to foist this thing upon others who must pay the cost, while they pay nothing, as they have succeeded in doing wherever the system has been adopted, and as they have tried to do here through the hearings of the house committee on coinage, weights and measures, they simply meddle with other people's affairs, and exhibit an assurance which furnishes the occasion, and I believe the justifiable occasion, for the vigorous language of 'The Metric Fallacy' which, however, has obviously not prevented Professor Stevens from learning some wholesome facts from it.

Contrast the enormous development of organized manufacturing to-day with its comparatively trifling development at the introduction of the metric system in France a century ago. Even with that trifling development Professor Stevens admits that 'conservatism has been too strong and vested interests too great to permit the enforcement of any interfering laws.' Is it not obvious that the change in France under the conditions of a century ago was easy compared with what it now is here? If, starting with the conditions of 1793, and after a century of compulsory laws, resort to the old units is in France still 'usual when no penalty is involved,' how many centuries must elapse before that resort becomes unusual under existing manufacturing development here where general compulsion is not to be contemplated?

Were the metric party to unite on the admissions made by Professor Stevens when presenting their case to the committee on coinage, weights and measures—and I shall see to it that they go before any such future committee—the metric bill would be killed at the hands of its friends as it was last winter killed at the hands of its enemies, for, contrary apparently to the impressions of Professor Stevens, the metric system from a legislative standpoint is the 'deadest' thing in this country.

F. A. HALSEY.

NEW YORK, August 30, 1904.

THE SONG OF BIRDS.

In view of the interest attached to the experiments made by Professor W. E. D. Scott with a view to ascertaining whether the song of birds is instinctive or imitative it may be well to recall that very similar experiments were made over a century ago. Wallace notes in his essays on 'Natural Selection, etc.,' that "The Hon. Daines Barrington was of the opinion that 'notes in birds are no more innate than language is in man, and depend entirely on the master under which they are bred, *as far as their organs will enable them to imitate* the sounds which they have frequent opportunities of hearing." An account of his experiments is given in the *Philosophical Transactions* for 1773, Vol. LXII., and his results were practically the same as those obtained by Professor Scott, the young birds acquiring the song of their foster parents and not the notes of their own species. Barrington notes that the birds must be taken from the nest when very young, as they are apt pupils and learn the call notes of their parents at an early age.

F. A. L.

Museum of the Brooklyn Institute,
August 28, 1904.

DOCTORATES AND FELLOWSHIPS.

To the Editor of Science: In Science for August 19 is the remark: 'It is somewhat surprising that California and Stanford have together conferred the degree (of Ph.D.) but twenty-five times in seven years.' Among the reasons for this are two: the authorities of this institution advise their advanced students, for the sake of breadth of experience, to take a part of their work in the east or in Europe. This is generally the concluding part. On the other hand, the California institutions grant few artificial aids to students as such. At Stanford this is regarded as a matter of principle, tuition being free to graduate students. By the wider introduction of the 'trading stamp system' in higher education, the number of degrees could be greatly increased, but with no gain to science or art.

David Starr Jordan.

SPECIAL ARTICLES.

LIMITATIONS OF THE KLINOSTAT AS AN INSTRUMENT FOR SCIENTIFIC RESEARCH.

The klinostat is an instrument used mostly in plant and animal physiology, revolving about either a vertical or a horizontal axis, for the purpose of neutralizing the tropic (curving) effects of light and gravitation. It was first made practical and introduced into laboratory work by Sachs in 1872, and fully described with additional improvements in several papers in that memorable series of pioneer research entitled 'Arbeiten des botanischen Instituts in Würzburg.'

The instrument as commonly manufactured is actuated by springs, and may be given several speeds, usually one revolution in ten, fifteen, twenty or thirty minutes. In the use of the instrument for demonstration and research during the past thirty years, it has generally been thought immaterial to consider the angles at which plants are secured to the horizontal klinostat for the purpose of neutralizing the tropic effect of gravitation, or to consider the distribution of light when plants are revolved on the vertical klinostat for the purpose of neutralizing the tropic effect of light. In addition to the foregoing relations of the instrument to gravitation and light, the present tendency to substitute electric and water motors for springs to drive the machines introduces relations of speed. The research of the past ten years has indicated very important limitations to the use of the klinostat, and the most general of these are pointed out in the following lines, and should be recognized by every one using this instrument.

Evenness of Speed.—The first requisite for securing evenness of revolution is the centering of the load. An excentric load will give a slower speed periodically, and this will bring curves. It has been shown in my own laboratory that, in a speed of one revolution in ten minutes, a periodic retardation of but a second or two, due to excentricity of load, will cause, after a long interval, a geotropic curve by the summation of stimuli.

Avoidance of Centrifugal Effect.—It is well known that in rapid revolution, plants simulate toward the so-called centrifugal force

their behavior toward gravitation. The revolution must be so slow therefore as not to bring in the centrifugal effect. Czapek* has measured the sensitiveness of plants to centrifugal force when gravitation is neutralized, finding that by sufficiently long continuance of the experiment, curves will come when the rate of revolution gives an acceleration exceeding one thousandth part of the acceleration of gravitation (.001 g.), but do not appear, at least for many hours, at a lower rate of speed. The relation of the acceleration due to rotation to the acceleration of gravitation is found by the formula $F = 4.024\, r/t^2$, in which r is the distance from the center of rotation in meters, t is the time of one revolution in seconds, and F is the ratio of the acceleration of rotation to the acceleration of gravitation. By applying the formula it will be found that an object rotating once in twenty seconds, at a distance of 10 cm. from the center will have an acceleration approximately equal to .001 g. Such a rate of revolution would, therefore, be within the limit of safety for objects less than 10 cm. from the center of rotation. To make the results doubly sure, one could keep a speed not to exceed one revolution per minute.

Avoidance of too Slow Revolution.—Not only is there an upper limit of speed, but a lower limit also when one wishes to neutralize the tropic effect of light or gravitation. A revolution that is so slow as to allow a plant to remain in one quadrant of its path, or, in certain cases, in one semicircle, for a period equal to the period required to produce a curvature when the plant is at rest, will produce a curvature of the plant on the klinostat, in which the apex of the plant member will, by combining its curves during a complete revolution of the klinostat, describe a line, as it moves back and forth, or a circle as it circumnutates, the one or the other according to the position of the plant with reference to the axis of revolution of the klinostat. Indeed, the recent work of F. Darwin and Pertz† may be taken to indicate that a plant on the horizontal klinostat, remaining in a quadrant for a period even less than the latent period of curvature may keep up a rhythmic oscillation as it revolves. Since at a temperature of 20° C. the latent period for curvature of some roots and stems is not over twenty minutes, and the perception period of some plants for gravitation at 20° C. is less than fifteen minutes, safety would advise that thirty minutes should be the limit for slow revolution, the plant then being in each quadrant but seven and one half minutes.

Not All Tropic Influences can be Neutralized by the Klinostat.—It is often desirable to revolve a plant on the klinostat, thereby freeing it from the tropic effect of gravitation in order that some property of the plant, ordinarily veiled by the control of gravitation, may be brought to expression. Thus the bending of several roots from light has been discovered by the use of the klinostat, the same roots showing no response to light as long as the stronger influence of gravitation was operative. It is well to know, however, that the so-called *autotropism* of plants is uninfluenced by the klinostat, and that this tendency of plants to grow straight must always operate against the formation of curves in plants that might otherwise show responses. This autotropism of roots and stems is of no inconsiderable moment, since curves of several hours' formation are by it completely obliterated while the plant is so revolved on the klinostat as to neutralize the tropic effect of gravitation.

It is of the first importance to know that only those parts of plants which are physiologically radially symmetrical will grow straight while revolving on the klinostat with horizontal axis.* A plant may be radially unsymmetrical toward gravitation, in which case, revolution on the klinostat will not release it wholly from the tropic influence of gravitation; or it may be radially unsymmetrical physiologically because of unsymmetrical behavior due to internal stimuli. In the revolution of the latter kind of plant member on the klinostat (many leaves), we may have curves due to unequal growth on the one side or the

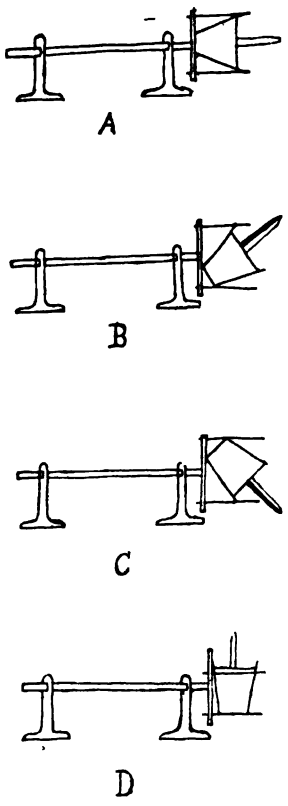
* *Jahrb. wiss. Bot.*, XXVII., 1895, 243.

† *Annals of Botany*, XVII., 1903, 93.

* Noll, *Jahrb. wiss. Bot.*, XXXIV., 1900, 459.

other, this unequal growth being known as *epinasty* or *hyponasty*.

How May Radially Symmetrical Plant Members be Placed on the Klinostat to Neutralize the Tropic Effect of Gravitation?—For neutralizing the tropic effect of gravitation the horizontal klinostat is always used. There are three positions the plants may occupy as they are fastened to the klinostat. The positions are illustrated by the four diagrammatic figures *A*, *B*, *C* and *D*. The position in *A*, in



which the axis of the plant is made parallel with the axis of rotation, is the one which has been most used in physiological work. The position in *B* and *C* is one in which plants have seldom been designedly placed, but in which parts of plants have been generally left without concern if in any way they came into this position. The question now to be considered is this: Are orthotropic parts of plants revolving on the klinostat as indicated in *A* and *B* freed from the tropic effect of gravitation? A consideration of the following results of recent investigation answers this question decisively in the negative. Czapek* found some evidence to show that primary roots, and Miss Pertz† showed that grass stems are not equally stimulated by gravitation at equal distances above and below the horizontal plane. Work done in the botanical laboratory here by Miss Haynes and myself, and soon to be published, demonstrates that both orthotropic roots and stems receive their strongest gravitation simulation for bending when those plant members are placed in the horizontal position; and that stems are more strongly stimulated to bend when inclined below the horizontal than at an equal angle above the horizontal, while roots are more strongly influenced when inclined with their tips above the horizontal than at equal angles below the horizontal. A stem, therefore, in the position shown in Fig. *B* does not feel the stimulation of gravitation so effectively as in the position 180° removed as in Fig. *C*. It is, however, entirely conceivable that the foregoing relations may be true for plants at rest, but may not hold for plants rotating on the klinostat. But numerous tests made by myself with several species show that both roots and stems rotated on the klinostat in the position shown in Figs. *B* and *C*, or in any oblique position between the horizontal and vertical, bend toward the horizontal as the experiment progresses. Not only then is the oblique inclination of the plant axis during revolution a faulty one, but the horizontal position as in Fig. *A* is not proper. In the latter position, it is true, the plant will grow straight, but it will grow straight for the same reason that it grows straight when at rest in the vertical position—because with each deviation from the horizontal position its geotropic response will send it back to the horizontal.

If one wishes to rotate orthotropic stems and roots on the klinostat so as to free them from the tropic effect of gravitation there is only one position possible, and that is the vertical position, by which the plant axis dur-

* *Jahrb. wiss. Bot.*, XXVII., 1895, 283.

† *Annals of Bot.*, XIII., 1899, 620.

ing revolution describes a vertical plane as shown in Fig. *D*.

If one wishes while the plant on the klinostat is freed from the tropic effect of gravitation to apply some stimulus for the study of a tropic reaction, the stimulus should be employed so as to cause curves in the plane of revolution; for as soon as the tip of stem or root deviates from the vertical plane, gravitation seizes upon it to turn it to the horizontal.

Neutralization of the Tropic Effect of Light.—Experiments in which plants are rotated to neutralize the tropic effects of gravitation have been mostly carried on in the dark-room with seedlings. Such conditions and material are easily obtained and managed. Sometimes, however, when the experiments are prolonged, and older plants are used, it is necessary to do the work in the light to avoid the appearance of pathological conditions. The requirements for such work are as manifold as the end sought and can not be considered here. It may be indicated that when the experimental plants are subjected to one-sided illumination as before a window, there are several adverse conditions that are not easily overcome. The common statement that the plants are to be rotated with the axis of the klinostat parallel with the window in order to neutralize the tropic effects of light leads to humiliation or self-deception. If the part of the plant sensitive to light is not at the center of rotation, it alternately as it revolves approaches and recedes from the light, receiving therefore more light on one side than on the other, and responding with phototropic curves. Or if so placed that it does not approach and recede from the window, it may on the horizontal klinostat, receive on one side its principal illumination from the sky and, on the opposite side of the plant, from the earth, thus again forming phototropic curves because of unequal stimuli. Several plants in a pot revolving on a klinostat with axis parallel with the window are likely to show curves because of the shadows which the plants cast on one another. Finally, the effort to neutralize the tropic effect of both light and gravitation on the same plants at the same time is so difficult as to require very special attention to the management of the light, unless the work is done in a plant-house with full exposure. A klinostat, such as has been devised, giving both vertical and horizontal revolution at the same time is not a guarantee against faulty results.

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QUOTATIONS.

THE PRESIDENTIAL ADDRESS BEFORE THE BRITISH ASSOCIATION.

MR. BALFOUR'S presidential address to the British Association naturally recalls another occasion in the history of that body when the chair was filled, not exactly by a prime minister, but by one who had been and very shortly again became prime minister. There is a marked resemblance between the address delivered at Oxford in 1894 by the late Lord Salisbury and that delivered yesterday in the seat of the sister University by his nephew and successor in office. It is entirely right and fitting that this should be the case, because on both occasions the British Association has listened, not to an expert in any one of the sciences, but to a student of the true *scientia scientiarum*. In a limited sense that proud title may be bestowed, as it was yesterday by Mr. Balfour, upon the science of physics. But the real *scientia scientiarum* consists in the assimilation by men of broad and sound general culture of the best and most assured results of the labors of specialists in many fields of research, and in the application of these results to life and conduct in domestic affairs, and to the solution of imperial problems in the wider arena of statesmanship. Of the countless millions who own allegiance to the king there is no man so deeply bound by duty and responsibility to master that difficult science as the prime minister of Great Britain. The obligation, it must be confessed, has sat very lightly upon many holders of that high office. We would fain hope that the appearance of two prime ministers in succession, showing incontestably that they possess a genuine appreciation of the vital necessity for knowledge in the direction of affairs, may be taken as a sign that a higher standard than that of political dexterity in appealing to ignorance

may by degrees be firmly established. We may anticipate the sneer that speculations on the nature of matter do not help much in dealing with what is called 'practical politics,' apparently because it consists chiefly of unpractical and impracticable verbiage. Perhaps not; but the intellectual habit and the intellectual capacity which impel and enable a man immersed in work to keep himself acquainted with the changing aspects of science upon which such speculations depend, do most potently help him in whatever business it may be his lot to transact. The precise color of his speculations is not very material, since it depends upon personal idiosyncracies of which the man himself could give none but the most inadequate account. In essence these speculations are as old as human thought, and all through the ages we find the most powerful intellects ranged on opposite sides. In form the speculations are constantly changing, and so are the names of the opposing parties. What we have to ask about a man is not on which side he stands, but what mastery he shows of the contemporary scientific achievement which gives to the secular controversy the form it wears for the men of his own time. That mastery, according to its degree, makes him an efficient intellectual force in whatever field he may choose to exert himself.—London *Times*.

AN ANCIENT FICTION.

The astonishing longevity of popular delusions in natural history is nowhere better illustrated than by the credence given even by educated folk at the present day to alleged discoveries of frogs, toads and other animals within hermetically sealed cavities, such as inside overgrown hollows of trees or closed interior spaces of rock.

Dr. Traquair, director of the Edinburgh Museum, mentions a letter published in the London *Times* a few years ago by the late Miss Amelia B. Edwards, the eminent Egyptologist, on the finding of a live toad deep down in boulder clay at Greenock, and refers to another accomplished author who took umbrage because some one ventured to question his assertion that live frogs occur in the Old Red Sandstone. Dr. Traquair is right in supposing beliefs of this nature to have considerable antiquity, although he professes ignorance as to how far back they can be traced into the past.

Probably not many will be surprised to learn that this popular delusion has a continuous history in literature of at least four hundred years; and if we include the so-called 'subterranean fish' of Narbonne, to which a special chapter is devoted in Rondelet's 'Ichthyology' (1554), a form of it is traceable as far back as the time of Aristotle. The occurrence of live fish underground, and the singular mode of taking them with the spade instead of the net, or hook and line, is mentioned repeatedly by classic authors, the most particular account being that of Polybius ('History,' xxxiv.). Older than these, though of scarcely germane nature, are the Biblical and secular legends of miraculous suspension of vital functions, of which the tale of the Seven Sleepers is an example.

References might be given to more than a score of sixteenth to eighteenth century writers who make more or less particular mention of the occurrence of live animals in cavities long closed to the air, the list including such prominent names as Conrad Gesner,* Agricola,† Francis Bacon,‡ Athanasius Kircher,§ Libavius|| and Astruc.¶ It is not, however, worth while to take further notice of these early accounts, unless it be one which is remarkable for its *naïveté* and evident truthfulness. This narrative is to be found in the surgical works (book xxv., cap. 18) of Ambroise Paré, court physician of Henry III.,

* 'De omni rerum fossilium, etc.,' Zurich, 1565.

† 'De Animantibus subterraneis,' Cap. XXXV., Wittenberg, 1614.

‡ 'Natural History,' opus posthumum, cent. vi., § 570. Bacon says here: 'The ancients have affirmed that there are some herbs that grow out of stone; which may be, for that it is certain that toads have been found in the middle of freestone.'

§ 'Mundus subterraneus,' lib. viii., Amsterdam, 1664 and 1678.

|| 'Singularium,' part i., de carne fossile; part iv., de Batrachiis, cap. 25.

¶ 'Mémoires pour l'Histoire naturelle de la Province de Languedoc,' part iii., chap. 10, Paris, 1737.

king of France and Poland, and sometimes called 'father of French surgery.' We would fain reproduce it in all the quaintness of the original, as follows:

Étant à une mienne vigne, près le village de Meudon, où je faisois rompre de bien grandes et grosses pierres solides, on trouva au milieu de l'une d'icelles un gros crapaud vif, et n'y avoit aucune apparence d'ouverture, et m'esmerveillai, comme cet animal avoit pû naître, croître et avoir vie. Lors le Carrier me dit qu'il ne s'en falloit esmerveiller, parce que plusieurs fois il avoit trouvé de tels et autres animaux au profond des pierres, sans apparence d'aucune ouverture.—(1564).

Differing in nowise from the above, except that they are attested by numerous reputable witnesses, are the accounts presented to the French Academy in the early days of its history, one such being preserved in the *Mémoires* for 1719, and another in the volume for 1731. Nor should one fail to note what the old Toulonese historians have said concerning edible mussels which the inhabitants cracked out of the solid rock in the harbor of their city. Instead of going clam-digging, those in search of a delicacy sallied forth with a hammer, and the shell-fish so obtained were said to have had an admirable flavor.*

Coming down to our own time and country, the curious will find in the *American Journal of Science* for 1822 (Vol. XIX., p. 167) an edifying description by Mr. David Thomas of the discovery of a live toad in a block of limestone during the excavation of the Erie Canal. The details of this incident, even including the fact that the toad got away, are authenticated by various 'witnesses of unimpeachable veracity,' one of them afterwards becoming a state senator, as we are told. And so with similar anecdotes, which meet the eye from time to time in the daily newspapers.

Not the slightest suspicion of untruthfulness in any of these instances is attached either to the narrator or to the spectators who corroborate the original statement to the best of their belief and knowledge. It is probably furthest from the minds of these worthy people wilfully to deceive the public, and yet, on the other hand, a little reflection shows that from the very nature of things such tales are incredible, and those who vouch for them must be mistaken in their observations, even as the most alert and sharp-sighted persons are deceived by the feats of a prestidigitator. The evidence given by the spectators would, so far as appearances go, be perfectly trustworthy, but when we subject their accuracy of observation and memory to the test of reason, which asks whether they relate that which is perforce impossible, the credibility of these witnesses is at once challenged. The fact remains that the sea serpent has not yet been captured, and in every instance these long-imprisoned frogs and toads and other animals have suddenly become vivified and succeeded in making their escape. Hence we are bound to agree with Dr. Traquair when he remarks that he 'should certainly not like to see the issue of a trial, civil or criminal, depend on the question of whether a man had seen the sea serpent, or had witnessed a family of young adders creeping down their mother's throat.'

* Bouche, H., 'Chorographie, ou Description de la Provence,' vol. i., p. 924, Paris, 1664. The account evidently refers to boring mollusks.

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SCIENTIFIC NOTES AND NEWS.

THE medal of the Society of Chemical Industry, awarded every second year for services to applied chemistry, has been presented to Dr. Ira Remsen, president of the Johns Hopkins University.

DR. LUDWIG SYLOW, professor of mathematics in the University of Christiania, has been made a foreign knight of the Prussian order 'pour le mérite.'

DR. MORITZ CANTOR, the well-known mathematician of the University of Heidelberg, celebrated recently his seventy-fifth birthday.

DR. WILLIAM H. WELCH, of the Johns Hopkins University, has given the Lane lectures at the Cooper Medical College, San Francisco, his subject being 'Infection and Immunity.'

WE learn from *Nature* that the Lancashire and Western Sea Fisheries Joint Committee has appointed Dr. J. T. Jenkins, professor of biology in Hartley University College, South-

ampton, to be superintendent of sea fisheries in place of the late Captain Dawson.

Dr. Frederick B. Loomis, of Amherst College, has during the present summer been engaged in exploring for fossils in Wyoming.

A life of Andrée is to be issued by the Geographical Society of Stockholm, of which he was a prominent member.

Mrs. Imogen W. Eddy, computer in the Harvard College Observatory, was killed by a fall from an elevator on September 4.

The death is announced of Dr. Frederic Zahn, formerly professor of anatomy at the University of Geneva; and of Dr. Emilio Valleri, professor of experimental physics at Naples.

Dr. Alexander Graham Bell has presented to the Station for Experimental Evolution of the Carnegie Institution, at Cold Spring Harbor, Long Island, a six-nippled ram and two five-nippled ewes, one white and one black, from the remarkable race of multi-nippled sheep that he has created on Cape Breton Island. The sheep will be used to test the method of inheritance of characters.

The late Dr. Albert W. Warden, of Union Hill, West Hoboken, has bequeathed $1,000 to the New York Academy of Medicine.

The Peruvian government is about to found a national museum of natural science, which will have its home in Lima, and in which there will be three departments, one devoted to animal life, another to plant life, and a third to minerals.

The British antarctic expedition steamer *Discovery* arrived at Plymouth on September 10.

It is announced that a powerful steamer will be built immediately at the McKay & Dix shipyard at Verona, on the Penobscot, for Commander Peary's next polar expedition. The steamer will be equipped with powerful engines and it is said that some new features will be embodied in the construction. It will cost between $300,000 and $400,000.

According to a press despatch the Ceylon mineralogical survey report gives details of the discovery of a mineral existing in small black cubical crystals in the refuse of the gem washings at Balangoda. The principal constituent is thorium oxide, of which there is present more than 75 per cent. The mineral appears to be new, and it is suggested that the name of thorianite be given to it, as it is radio-active.

There will be a civil service examination on September 14 for the position of aid and deck officer in the Coast and Geodetic Survey and one for the position of computer on September 19. Deck officers are appointed with salaries of $720 to $900 and computers receive salaries of from $1,000 to $2,000. Further information may be obtained from the active superintendent of the survey. Applications for the position of scientific aid (female) in the Bureau of Plant Industry, Department of Agriculture, will be received by the Civil Service Commission until September 28, 1904. Applicants must be graduates of colleges in courses of study tending to qualify them for the scientific work of the Department of Agriculture. They are not assembled for this examination, but must submit all the required material with their applications.

The U. S. Geological Survey has in the government building of the St. Louis Exposition an exhibit of radio-active substances, prepared under the direction of Dr. George F. Kunz, which will be of interest to scientific men who visit the exposition. It includes specimens from M. Becquerel, Sir William Crookes and Professor Ernest Rutherford and others. Everything obtainable relating to the source, manufacture and application of radium is exhibited, including all chemicals obtained from the separation of various radium compounds, and all instruments and devices with which it is proposed to apply radio-activity in medicine, science and the arts. A feature is the portraits and the publications of investigators, together with photographs of their laboratories and apparatus, and autograph letters from some of them. Two halls have been set aside for demonstration of the properties of radium. In one are grouped the specimens of ores and minerals containing radium. In the other illustrated lectures are given daily at 11:30 A.M. and 3 P.M. on a variety of subjects re-

lating to the history, nature and possibilities of radium. Its mode of occurrence, the methods used in separating it from its ores, the concentration of activities from low to high, and the manifold uses to which these remarkable radio-active substances may be put are described. Cinematograph Hall can be darkened, and different highly active specimens of radium compounds are exhibited as affecting the diamond, willemite, kunzite and other radio-responsive substances.

AT the last monthly general meeting of the Zoological Society of London the report of the council for July was read by the secretary, Dr. P. Chalmers Mitchell. It was stated that during the month 180 additions had been made to the society's menagerie. The total number of visitors to the society's gardens during the year up to the end of July was 417,170, an increase of 48,738 on the numbers for the corresponding period of last year. The number of fellows elected and readmitted during the year up to the end of July was 165, an increase of 31 as compared with the corresponding period of 1903.

Nature states that with the view to obtain further information on the growth and migrations of salmon (including sea-trout, salmon-trout, peal, sewin, etc.), the British Board of Agriculture and Fisheries had had a number of such fish 'marked' by attaching a small oblong silver label (oxidized, or blackened, and bearing distinctive letters and numbers) to the dorsal or large back fin. Small rewards will be paid for the recovery of fish bearing such labels or other 'marks,' or for information respecting them. The Board has prepared lists of persons in the south and west of England, in Wales and Monmouthshire, and in the north of England, who will receive marked fish. The experiments will be continued during a series of years, and the co-operation of net-fishermen, anglers, fishmongers, and all interested in the improvement of the salmon fisheries, is invited in order that the fullest possible results may be secured.

THE London *Times* says that the first instalment of specimens and a number of scientific instruments have arrived in Edinburgh from the *Scotia*. Many of the instruments were of so delicate a character that they had to be carried unpacked in the hands of those assisting in the transfer. Of specimens there were transshipped about 200 barrels, cases and packages. It is calculated that several years will be occupied in the classification of the immense amount of animal and oceanographic specimens which Dr. Bruce has brought home with him, and the contents of the great casks which contain the larger specimens will, even in rough sorting, take up some considerable amount of time. The larger specimens of oceanic life, upon being taken from the casks in which they have traveled so far, are placed in a specially designed zinc tub filled with methylated spirits and fitted with a rubber-rimmed lid, forming an excellent method of preservation. It is officially stated that a report which has been published regarding the sale of the *Scotia* is inaccurate.

THE U. S. Geological Survey has recently perfected plans for the systematic collection and preservation of well records and samples. The demand for information regarding wells has become so great that the survey has decided to issue an annual publication containing a brief account of the wells bored each year. This report will be published as near the beginning of the year as practicable, and will be sent to all those who apply for it. It will contain the names and addresses of persons doing well work and will summarize the work done by them in the preceding year. In order to obtain data for such a year book, the survey wishes to make arrangements with well drillers and well owners to send samples and records to the survey's headquarters in Washington, D. C. On receipt of names of persons willing to save samples of well borings the Survey will at once send them supplies of canvas bags in which they may transmit them through the mails without paying postage. As these samples may be sent as often as the drillers visit the postoffice, there is no danger that they will accumulate and become burdensome. For the keeping of a log a convenient pocket memorandum book will also be provided. It is hoped that the drillers and well

owners of the country will appreciate the importance of the Survey's effort and will cooperate so heartily as to assure its complete success. It should appeal to them for several reasons: (1) Their names and work will be kept before a class of readers interested in well drilling. (2) Records of their work will be carefully filed in the office of the survey, and will be readily available to them at any time, so that in case their notes are lost they can be duplicated. (3) Their cooperation will aid materially in the study of the geologic structure of the United States, and will thus assist in obtaining knowledge which can not fail to be of ultimate benefit to well drillers. It may sometimes be necessary to regard the records as confidential. In such cases the information will be carefully guarded and used only under the conditions stipulated by the informant. The director of the survey will be glad to have an expression of opinion regarding this work from well owners and drillers, and will be grateful to them for any suggestions.

UNIVERSITY AND EDUCATIONAL NEWS.

THE courts have confirmed the bequest of $40,000 made by the late Dr. William H. Crim to the University of Maryland School of Medicine.

THE Cooper Medical College, of San Francisco, has received a bequest from Mrs. Pauline C. Lane, wife of the late Dr. C. L. Lane, which enables it to build a library.

IT is stated in *Nature* that Mr. Frederick Soddy has concluded a series of university extension lectures in Western Australia. The last lecture was delivered on July 23, and on this occasion the premier of the colony, Mr. Walter James, in proposing a vote of thanks to Mr. Soddy, referred to the desirability of establishing a university in Western Australia. During the course of the last twelve months one distinct step has been taken in advancing the movement by the passage of the University Endowment Act. Endowment trustees have been appointed, and in these trustees some 700 or 800 acres of land have been vested, which promise to give the future university the richest endowment enjoyed by any university in Australia. They were very apt to think, Mr. James continued, that no university could be established unless they first expended a large sum of money in an elaborate building. He wished only they could convince the residents of Western Australia that so long as they had efficient workshops for their professors, the sooner they commenced to get their professors the sooner could they begin the work of the university, without money overburdening it in the first instance. Mr. Soddy's visit has done good in bringing home more thoroughly than before how necessary it is that the establishment of this university should be commenced without undue delay.

THE position of assistant in bacteriology in the Laboratory of Hygiene, University of Pennsylvania, and the Thomas A. Scott fellowship in hygiene in the same laboratory are vacant for the year 1904–1905. Further information may be obtained from the director of the laboratory.

MR. WILL GRANT CHAMBERS has been called from the chair of psychology and education in State Normal School at Moorhead, Minn., to the chair of psychology in the State Normal School of Colorado, at Greeley.

DR. H. T. MARSHALL has been appointed professor of pathology at Baltimore Medical College.

L. C. KARPINSKI, A.B. (Cornell, '01), Ph.D. (Strassburg, '03), and John W. Bradshaw, A.M. (Harvard), Ph.D. (Strassburg, '04), have been appointed instructors in mathematics in the University of Michigan.

PROFESSOR LORRAIN SMITH, of Belfast, and Dr. A. S. Grünbaum, of Liverpool, have been appointed to chairs of pathology, respectively, at the Universities of Manchester and Leeds.

DR. H. BATTERMANN, astronomer at the Berlin Observatory, has been appointed professor of astronomy at the University of Königsberg.

PROFESSOR O. E. MEYER, director of the physical laboratory of the University of Breslau, will retire from active service.

SCIENCE

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FRIDAY, SEPTEMBER 23, 1904.

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*THE EVOLUTION OF THE SCIENTIFIC INVESTIGATOR.**

AMONG the tendencies characteristic of the science of our day is one toward laying greater stress on questions of the beginning of things, and regarding a knowledge of the laws of development of any object of study as necessary to its complete understanding in the form in which we find it. It may be conceded that the principle here involved is as applicable in the broadest field of thought as in a special research into the properties of the minutest organism. It, therefore, seems meet that the comprehensive survey of the realm of knowledge on which we are about to enter should begin by seeking to bring to light those agencies which have brought about the remarkable development of that realm to which the world of to-day bears witness. The principle in question is recognized in the plan of our proceedings by providing for each great department of knowledge a review of its progress during the century that has elapsed since the great event which the scene around us is intended to commemorate. But such reviews do not make up that general survey of science at large which is necessary to the development of our theme, and which must include the action of causes that had their origin long before our time. The movement which culminated in making the nineteenth century ever memorable in history is the outcome of a long series of causes, acting through many centuries, which are worthy

* Opening address of the president of the International Congress of Arts and Science, at the St. Louis Exposition, September 19, 1904.

of being brought into especial prominence on such an occasion as this. In setting them forth we should avoid laying stress on those visible manifestations which, striking the eye of every beholder, are in no danger of being overlooked, and search rather for those agencies whose activities underlie the whole visible scene, but which are liable to be blotted out of sight by the very brilliancy of the results to which they have given rise. It is easy to draw attention to the wonderful qualities of the oak; but, from that very fact, it may be needful to point out that the real wonder lies concealed in the acorn from which it grew.

Our inquiry into the logical order of the causes which have made our civilization what it is to-day will be facilitated by bringing to mind certain elementary considerations—ideas so familiar that setting them forth may seem like citing a body of truisms—and yet so frequently overlooked not only individually, but in their relation to each other, that the conclusion to which they lead may be lost to sight. One of these propositions is that psychical rather than material causes are those which we should regard as fundamental in directing the development of the social organism. The human intellect is the really active agent in every branch of endeavor—the *primum mobile* of civilization—and all those material manifestations to which our attention is so often directed are to be regarded as secondary to this first agency. If it be true that 'in the world is nothing great but man; in man is nothing great but mind,' then should the keynote of our discourse be the recognition at every step of this first and greatest of powers.

Another well-known fact is that those applications of the forces of nature to the promotion of human welfare which have made our age what it is are of such comparatively recent origin that we need go back only a single century to antedate their most important features, and scarcely more than four centuries to find their beginning. It follows that the subject of our inquiry should be the commencement, not many centuries ago, of a certain new form of intellectual activity.

Having gained this point of view our next inquiry will be into the nature of that activity, and its relation to the stages of progress which preceded and followed its beginning. The superficial observer, who sees the oak but forgets the acorn, might tell us that the special qualities which have produced such great results are expert scientific knowledge and rare ingenuity, directed to the application of the powers of steam and electricity. From this point of view the great inventors and the great captains of industry were the first agents in bringing about the modern era. But the more careful inquirer will see that the work of these men was possible only through a knowledge of laws of nature which had been gained by men whose work took precedence of theirs in logical order, and that success in invention has been measured by completeness in such knowledge. While giving all due honor to the great inventors, let us remember that the first place is that of the great investigators whose forceful intellects opened the way to secrets previously hidden from men. Let it be an honor and not a reproach to these men that they were not actuated by the love of gain, and did not keep utilitarian ends in view in the pursuit of their researches. If it seems that in neglecting such ends they were leaving undone the most important part of their work, let us remember that nature turns a forbidding face to those who pay her court with the hope of gain, and is responsive only to those suitors whose love for her is pure and undefiled. Not only is the special genius required in the investigator not that generally best adapted to applying the discov-

eries which he makes, but the result of his having sordid ends in view would be to narrow the field of his efforts, and exercise a depressing effect upon his activities. It is impossible to know what application knowledge may have until after it is acquired, and the seeker after purely useful knowledge will fail to acquire any real knowledge whatever.

We have here the explanation of the well-known fact that the functions of the investigator of the laws of nature, and of the inventor who applies these laws to utilitarian purposes are rarely united in the same person. If the one conspicuous exception which the past century presents to this rule is not unique, we should probably have to go back to Watt to find another. The true man of science of to-day and of all past time has no such expression in his vocabulary as useful knowledge. His domain is the whole of nature, and were he to attempt its division into the useful and the useless, he would drop from his high estate.

It is, therefore, clear that the primary agent in the movement which has elevated man to the masterful position he now occupies is the scientific investigator. He it is whose work has deprived plague and pestilence of their terrors, alleviated human suffering, girdled the earth with the electric wire, bound the continent with the iron way, and made neighbors of the most distant nations. As the first agent which has made possible this meeting of his representatives, let his evolution be this day our worthy theme.

It has been said that the scientific investigator is a new species of the human race. If this designation is applicable to a class defined only by its functions, then it is eminently appropriate. But the biologist may object to it on the ground that a species, or even a variety, is the product of heredity, and propagates only or mainly its own kind. The evolutionist may join hands with him on the ground that only new faculties, not new modes of activity, are to be regarded as products of evolution, but let us not stop to dispute about words. We have no need of the term 'species' in our present course of thought; but to deny the term evolution to the genesis of previously non-existent forms of intellectual activity is to narrow our conception of the course of nature, and draw a line of demarkation where no tangible boundary exists.

I am the more ready to invite your attention to the evolution of the scientific investigator, not only because the subject is closely correlated with human evolution in general, but because it is one branch of evolution which seems to me not to have received due prominence in discussions of the subject.

In our time we think of the process of development in nature as one going continuously forward through the combination of the opposite processes of evolution and dissolution. The tendency of our thought has been in the direction of banishing cataclysms to the theological limbo, and viewing nature as a sleepless plodder, endowed with infinite patience, waiting through long ages for results. I do not contest the truth of the principle of continuity on which this view is based. But it fails to make known to us the whole truth. The building of a ship from the time that her keel is laid until she is making her way across the ocean is a slow and gradual process; yet there is a cataclysmic epoch in her history, opening up a new era in her existence. It is the moment when, after lying for months or years a dead, inert, immovable mass, she is suddenly endowed with the power of motion and, as if imbued with life, glides into the stream, soon to begin a career of restless activity, of which the only bounds are those of the

ocean. I think it is thus in the development of humanity. Long ages may pass during which a race, to all external observations, appears to be making no real progress. Additions may be made to learning, and the records of history may constantly grow, but there is nothing in its sphere of thought or in the features of its life that can be called radically new. Yet, nature may have been all along slowly working in a way which evades our scrutiny until the result of her operations suddenly appears in a new and revolutionary movement, carrying the race to a higher plane of civilization.

It is not difficult to point out such epochs in human progress. The greatest of all, because it was the first, is one of which we find no record either in written or geological history. It was the epoch when our progenitors first took conscious thought of the morrow, first used the crude weapons which nature had placed within their reach to kill their prey, first built a fire to warm their bodies and cook their food. I love to fancy that there was some one first man, the Adam of evolution, who did all this, and who used the power thus acquired to show his fellows how they might profit by his example. When the members of the tribe or community which he gathered around him began to conceive of life as a whole—to include yesterday, to-day and to-morrow in the same mental grasp—to think how they might apply the gifts of nature to their own uses—a movement was begun which should ultimately lead to civilization.

Many, indeed, must have been the ages required for the development of this rudest primitive community into the civilization revealed to us by the most ancient tablets of Egypt and Assyria. After spoken language was developed, and after the rude representation of ideas by visible marks drawn to resemble them had long been practised, some real Cadmus must have invented an alphabet. When the use of a written language was thus introduced, the word of command ceased to be confined to the range of the human voice, and it became possible for master minds to extend their influence as far as a written message could be carried. Then were communities gathered into provinces, provinces into kingdoms, and kingdoms into the great empires of antiquity. Then arose a stage of civilization which we find pictured in the most ancient records—a stage in which men were governed by laws that were perhaps as wisely adapted to their conditions as our laws are to ours—in which the phenomena of nature were rudely observed, and striking occurrences in the earth or in the heavens recorded in the annals of the nation.

Vast was the progress of knowledge during the interval between these empires and the century preceding that in which modern science began. Yet, if I am right in making a distinction between the slow and regular steps of progress, each growing naturally out of that which preceded it, and the entrance of the mind at some fairly definite epoch into an entirely new sphere of activity, it would appear that there was only one such epoch during the entire interval. This was when abstract geometrical reasoning commenced, and astronomical observations aiming at precision were recorded, compared and discussed. Closely associated with it must have been the construction of the forms of logic. The radical difference between the demonstration of a theorem of geometry and the reasoning of every-day life, which the masses of men must have used from the beginning, and which few even to-day ever get beyond, is so evident at a glance that I need not dwell upon it. The principal feature of this advance is that by one of those antinomies of the human intellect of which examples are not wanting even in our own

time, the development of abstract ideas among the Greeks preceded the concrete knowledge of natural phenomena. When we reflect that in the geometry of Euclid the science of space was brought to such logical perfection that even to-day its teachers are not agreed as to the practicability of any radical improvement upon it, we can not avoid the feeling that a very slight change in the direction of the intellectual activity of these people would have led to the beginning of natural science. But it would seem that the very purity and perfection which was aimed at in their system of geometry stood in the way of any extension or application of its methods and spirit to the field of nature. One example of this is worthy of attention. In modern teaching the idea of magnitude as generated by motion is freely introduced. A line is described by a moving point; a plane by a moving line; a solid by a moving plane. It may, at first sight, seem singular that this conception finds no place in the Euclidian system. But we may regard the omission as a mark of logical purity and rigor. Had the real or supposed advantages of introducing motion into geometrical conceptions been suggested to Euclid, we may suppose him to have replied that the theorems of space are independent of time; that the idea of motion necessarily implies time, and that, in consequence, to avail ourselves of it would be to introduce an extraneous element into geometry. The result was that, in keeping this science pure from ideas which did not belong to it, it failed to form what might otherwise have been the basis of physical science. Its founders missed the discovery that the methods of geometric demonstration could be extended into other and wider fields than that of space. Thus not only the development of applied geometry, but the reduction of other conceptions to a rigorous mathematical form was indefinitely postponed.

The idea of continuous increase in time is that by which the conceptions of the infinitesimal calculus can most easily find root in the mind of the beginner. It is quite possible that the contempt of the ancient philosophers for the practical application of their science, which has continued in some form to our own time, and which is not altogether unwholesome, was a powerful factor in preventing the development of this idea.

Astronomy is necessarily a science of observation pure and simple, in which experiment can have no place except as an auxiliary. The vague accounts of striking celestial phenomena, handed down by the priests and astrologers of antiquity, were followed in the times of the Greeks by observations having, in form at least, a rude approach to precision, though nothing like the degree of precision that the astronomer of to-day would reach with the naked eye, aided by such rude instruments as he could fashion from the tools at command of the ancients.

The rude observations commenced by the Babylonians were continued with gradually improving instruments, first by the Greeks and then by the Arabians; but the results failed to afford any insight into the true relation of the earth to the heavens. What was most remarkable in this failure is that to take a first step forward, which would have led on to success, no more was necessary than a course of abstract thinking vastly easier than that required for working out the problems of geometry. That space is infinite is an unexpressed axiom, tacitly assumed by Euclid and his successors. Combining this with the most elementary consideration of the properties of the triangle, it would be seen that a given body of any size could be placed at such a distance in space as to appear to us like a

point. Hence a body as large as our earth, which was known to be a globe from the time that the ancient Phœnicians navigated the Mediterranean, if placed in the heavens at a sufficient distance, would look like a star. The obvious conclusion that the stars might be bodies like our globe, shining either by their own light or by that of the sun, would have been a first step to an understanding of the true system of the world.

There is historic evidence that this deduction did not wholly escape the Greek thinkers. It is true that the critical student will assign little weight to the current belief that the vague theory of Pythagoras that fire was at the center of all things, implies a conception of the heliocentric theory of the solar system. But the testimony of Archimedes, confused though it is in form, leaves no serious doubt that Aristarchus of Samos not only propounded the view that the earth revolves both on its own axis and around the sun, but that he correctly removed the great stumbling-block in the way of this theory by adding that the distance of the fixed stars was infinitely greater than the dimensions of the earth's orbit. Even the world of philosophy was not yet ready for this conception, and so far from seeing the reasonableness of the explanation, we find Ptolemy arguing against the rotation of the earth on grounds which careful observations of the phenomena around him would have shown to be ill founded.

Physical science, if we can apply that term to an uncoordinated body of facts, was successfully cultivated from the earliest times. Something must have been known of the properties of metals, and the art of extracting them from their ores must have been practised from the time that coins and medals were first stamped. The properties of the most common chemical compounds were discovered by alchemists in their vain search for the philosopher's stone, but no actual progress worthy of the name rewarded the practitioners of the black art.

Perhaps the first approach to a correct method was that of Archimedes who, after careful thinking, worked out the law of the lever, reached the conception of the center of gravity, and demonstrated the first principles of hydrostatics. It is, therefore, all the more remarkable that he did not extend his researches into the phenomena of motion, whether spontaneous or produced by force. The stationary condition of the human intellect was most strikingly illustrated by the fact that not until the time of Leonardo was any substantial advance made on his discovery. To sum up in one sentence the most characteristic feature of ancient and medieval science, we see a notable contrast between the precision of thought implied in the construction and demonstration of geometrical theorems and the vague, indistinct character of the ideas of natural phenomena generally, a contrast which did not disappear until the foundations of modern science began to be laid.

We should miss the most essential point of the difference between medieval and modern learning if we looked upon it as mainly a difference either in the precision or the amount of knowledge. The development of both of these qualities would, under any circumstances, have been slow and gradual, but sure. We can hardly suppose that any one generation, or even any one century, would have seen the complete substitution of exact for inexact ideas. Slowness of growth is as inevitable in the case of knowledge as in that of a growing organism. The most essential point of difference is one of those seemingly slight ones, the importance of which we are too apt to overlook. It was like the drop of blood in the wrong place, which some one has told us makes all the difference between

a philosopher and a maniac. It was the difference between a live tree and a dead one; between an inert mass and a growing organism. The transition of knowledge from the dead to the living form must, in any complete review of the subject, be looked upon as the really great event of modern times. Before this event the intellect was bound down by a scholasticism which regarded knowledge as a rounded whole, the parts of which were written in books and carried in the minds of men. The student was taught from the beginning of his work to look upon authority as the foundation of his beliefs. The older the authority, the greater the weight it carried. So effective was this teaching that it seemed never to have occurred to individual men that they had every opportunity enjoyed by Aristotle of discovering truth, with the added advantages of all his knowledge to begin with. With all the development of formal logic, that practical logic which could see that the last of a series of authorities, every one of which rested on those which preceded it, could never form a surer foundation for any doctrine than that supplied by its original propounder. The result of this view of knowledge was that, although during the fifteen centuries following the death of the geometer of Syracuse, great universities were founded at which generations of professors expounded all the learning of their time, neither professor nor student ever suspected what latent possibilities of good were concealed in the most familiar operations of nature. Every one felt the wind blow, saw water boil and heard the thunder crash, but never thought of investigating the forces here at play. Up to the middle of the fifteenth century the most acute observer could scarcely have seen the dawn of a new era.

In view of this state of things it must be regarded as one of the most remarkable facts in evolutionary history that four or five men, whose mental constitution was either typical of the new order of things or who were powerful agents in bringing it about, were all born during the fifteenth century—four of them at least at so nearly the same time as to be contemporaries.

Leonardo da Vinci, whose artistic genius has charmed succeeding generations, was also the first practical engineer of his time, and the first man after Archimedes to make a substantial advance in developing the laws of motion. That the world was not prepared to make use of his scientific discoveries does not detract from the significance which must attach to the period of his birth.

Shortly after him was born the great navigator whose bold spirit was to make known a new world, thus giving to commercial enterprise that impetus which was so powerful an agent in bringing about a revolution in the thoughts of men.

The birth of Leonardo was shortly followed by that of Copernicus, the first after Aristarchus to demonstrate the true system of the world. In him more than in any of his contemporaries do we see the struggle between the old modes of thought and the new. It seems also pathetic and is certainly most suggestive of the general view of knowledge taken at this time that, instead of claiming credit for bringing to light great truths before unknown, he made a labored attempt to show that, after all, there was nothing really new in his system, which he claimed to date from Pythagoras and Philolaus. In this connection it is curious that he makes no mention of Aristarchus who, I think, will be regarded by conservative historians as his only demonstrated predecessor. To the hold of the older ideas upon his mind we must attribute the fact that in constructing his system he took great pains to make as little change as possible in ancient conceptions.

Luther, the greatest thought-stirrer of them all, practically of the same generation with Copernicus, Leonardo and Columbus, does not come in as a scientific investigator, but as the great loosener of chains which had so fettered the intellects of men that they dared not think otherwise than as the authorities had thought. Later in the same century was born Paracelsus, in whose checkered life we see, as in the case of Copernicus, the struggle between the old modes of thought and the new.

Almost coeval with the advent of those intellects was the discovery of the art of printing with movable type. Gutenberg was born during the first decade of the century, and his associates and others credited with the invention not many years afterward. If we accept the principle on which I am basing my argument, that we should assign the first place to the birth of those psychic agencies which started men on new lines of thought, then surely was the fifteenth the wonderful century!

Let us not forget that, in assigning the actors then born to their places, we are not recounting history, but studying a special phase of evolution. It matters not for us that no university invited Leonardo to its halls, and that his science was valued by his contemporaries only as an adjunct to the art of engineering. The great fact still is that he was the first of mankind to propound laws of motion. It is not for anything in Luther's doctrines that he finds a place in our scheme. No matter for us whether they were true or false. What he did toward the evolution of the scientific investigator was to show by his example that a man might question the best established and most venerable authority and still live—still preserve his intellectual integrity—still command a hearing from nations and their rulers. It matters not for us whether Columbus ever knew that he had discovered a new continent. His work was to teach that neither hydra, chimera nor abyss—neither divine injunction nor infernal machination—was in the way of men visiting every part of the globe, and that the problem of conquering the world reduced itself to one of sails and rigging—hull and compass. The better part of Copernicus was to direct man to a view point whence he should see that the heavens were of like matter with the earth. All this done, the acorn was planted from which the oak of our civilization should spring. The mad quest for gold which followed the discovery of Columbus—the questionings which absorbed the attention of the learned—the indignation excited by the seeming vagaries of a Paracelsus, the fear and trembling lest the strange doctrine of Copernicus should undermine the faith of centuries—were all helps to the germination of the seed—stimuli to thought which urged it on to explore the new fields opened up to its occupation. This given, all that has since followed came out in the regular order of development, and need be here considered only in those phases having a special relation to the purpose of the present assembly.

So slow was the growth at first that the sixteenth century may scarcely have recognized the inauguration of a new era. Torricelli and Benedetti were of the third generation after Leonardo; and Galileo, the first to make a substantial advance upon his theory, was born more than a century after him. Only two or three men appeared in a generation who, working alone, could make real progress in discovery, and even these could do little in leavening the minds of their fellowmen with the new ideas. Up to the middle of the seventeenth century an agent which all our experience since that time shows to be necessary to the most productive intellectual activity was wanting. This was the attrition of like minds, making suggestions to each

other, criticising, comparing and reasoning. This element was introduced by the organization of the Royal Society of London and the Academy of Sciences of Paris. The members of these two bodies seem like ingenious youths suddenly thrown into a new world of interesting objects, the purposes and relations of which they had to discover for themselves. The novelty of the situation is strikingly shown in the questions which occupied the minds of the incipient investigators. One natural result of British maritime supremacy was that the aspirations of the fellows of the Royal Society were not confined to any continent or hemisphere. Inquiries were sent all the way to Batavia to know 'whether there be a hill in Sumatra which burneth continually, and a fountain which runneth pure balsam.' The astronomical precision with which it seemed possible that physiological operations might go on was evinced by the inquiry whether the Indians can so prepare that stupefying herb datura that 'they make it lie several days, months, years according as they will, in a man's body without doing him any harm, and at the end kill him without missing an hour's time.' Of this continent one of the inquiries was whether there be a tree in Mexico that yields water, wine, vinegar, milk, honey, wax, thread and needles.

Among the problems before the Paris Academy of Sciences those of physiology and biology took a prominent place. The distillation of compounds had long been practised, and the fact that the more spirituous elements of certain substances were thus separated naturally led to the question whether the essential essences of life might not be discoverable in the same way. In order that all might participate in the experiments, they were conducted in the full session of the academy, thus guarding against the danger of any one member obtaining for his exclusive personal use a possible elixir of life. Cats, dogs, birds of various species, a wide range of the animal and vegetable kingdom, in fact, were thus analyzed. The practise of dissection was introduced on a large scale. That of the cadaver of an elephant occupied several sessions, and was of such interest that the monarch himself was a spectator.

To the same epoch with the formation and first work of these two bodies belongs the invention of a mathematical method which in its importance to the advance of exact science may be classed with the invention of the alphabet in its relation to the progress of society at large. The use of algebraic symbols to represent quantities had its origin before the commencement of the new era, and gradually grew into a highly developed form during the first two centuries of that era. But this method could represent quantities only as fixed. It is true that the elasticity inherent in the use of such symbols permitted of their being applied to any and every quantity; yet, in any one application, the quantity was considered as fixed and definite. But most of the magnitudes of nature are in a state of continual variation; indeed, since all motion is variation, the latter is a universal characteristic of all phenomena. No serious advance could be made in the application of the algebraic method to the expression of physical phenomena until the language of that method could be so extended as to express variation in quantities, as well as the quantities themselves. This extension, worked out independently by Newton and Leibnitz, must be classed among the greatest epoch-making conceptions in exact science. With it the way was opened for the unimpeded and continually accelerated progress of the last two centuries. The feature of this period which has the closest relation to the purpose of our coming together is the seemingly unending subdivision of knowledge

into specialties, many of which are becoming so minute and so isolated that they seem to have no interest to any but their few pursuers. Happily, science itself has afforded a corrective for its own tendency in this direction. The careful thinker will see that in these seemingly diverging branches common elements and common principles are coming more and more to light. There is an increasing recognition of methods of research and of deduction which are common to large branches or to the whole of science. We are more and more recognizing the principle that progress in knowledge implies its reduction to a more exact form, and the expression of its ideas in language more or less mathematical. The problem before the organizers of this congress was, therefore, to bring the sciences together, and seek for the unity which we believe underlies their infinite diversity. The assembling of such a body as now fills this hall was scarcely possible in any preceding generation, and is made possible now only through the agency of science itself. It differs from all preceding international meetings by the universality of its scope, which aims to include the whole of knowledge. It is also unique in that none but leaders have been sought out as members. It is unique in that so many lands have delegated their choicest intellects to carry on its work. They come from the country to which our republic is indebted for a third of its territory, including the ground on which we stand; from the land which has taught us that the most scholarly devotion to the languages and learning of the cloistered past is compatible with leadership in the practicable application of modern science to the arts of life; from the island whose language and literature have found a new field and a vigorous growth in this region; from the last seat of the holy Roman Empire; from the country which, boasting of the only monarch that ever made an astronomical observation at the Greenwich Observatory, has enthroned science in one of the highest places in its government; from the peninsula so learned that we have invited one of its scholars to come here and teach us our own language; from the land which gave birth to Leonardo, Galileo, Torricelli, Columbus, Volta—what an array of immortal names!—from the little republic of glorious history which, breeding men rugged as its eternal snow-peaks, has yet been the seat of scientific investigation since the day of the Bernoullis; from the land whose heroic dwellers did not hesitate to use the ocean itself to protect it against invaders, and which now makes us marvel at the amount of erudition compressed within its little area; from the nation of the farthest east, which, by half a century of unequaled progress in the arts of life, has made an important contribution to evolutionary science through demonstrating the falsity of the theory that the most ancient races are doomed to be left in the rear of the advancing age—in a word, from every great center of intellectual activity on the globe I see before me eminent representatives of that world-advance which we have come to celebrate.

Gentlemen and scholars all! You do not visit our shores to find great collections in which long centuries of humanity have given expression on canvas and in marble to their hopes, fears and aspirations. Nor do you expect institutions and buildings hoary with age. But as you feel the vigor latent in the fresh air of these expansive prairies, which has collected the products of human genius by which we are here surrounded and, I may add, brought us together—as you study the institutions which we have founded for the benefit not only of our own people but of humanity at large; as you meet the men who, in the short space of one century, have transformed this val-

ley from a savage wilderness into what it is to-day—then may you find compensation for the want of a past like yours by seeing with prophetic eye a future world power of which this region shall be the seat. If such is to be the outcome of the institutions which we are now building up, then may your present visit be a blessing both to your posterity and ours, by making that power one for good to all mankind. Your deliberation will help to demonstrate to us and to the world at large that the reign of law must supplant that of brute force in the relations of the nations, just as it has supplanted it in the relations of individuals. You will help to show that the war which science is now waging against the sources of disease, pain and misery offers an even nobler field for the exercise of heroic qualities than can that of battle. We hope that when, after your all too fleeting sojourn in our midst, you return to your own shores, you will long feel the influence of the new air you have breathed in an infusion of increased vigor in pursuing your varied labors. And if a new impetus is thus given to the great intellectual movement of the past century, resulting not only in promoting the unification of knowledge, but in widening its field through new combinations of effort on the part of its votaries, the projectors, organizers and supporters of this Congress of Arts and Science will be justified of their labors.

SIMON NEWCOMB.

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*THE EVIDENCE OF EVOLUTION.**

MR. PRESIDENT, MEMBERS OF THE UNIVERSITY OF CHICAGO, LADIES AND GENTLEMEN:

The noble aim of university teaching is the lifting up of mankind to a higher appreciation of the ideas of life and truth. It has to cultivate the most intimate connection between theory and practise, between abstract science and actual life. Throughout the world of research this connection is felt to be the real stimulus of the work, the very basis of its existence. American universities and American science have developed themselves on this leading principle, and it is especially on this account that high admiration is given them by their European sisters. Nowhere in this world is the mutual concourse between practise and science so general as here, and nowhere is the influence of the universities so widely felt as in this country. Perfect freedom of thought and investigation, unhampered rights of professing and defending one's conviction, even if it should be wholly contrary to the universal belief, are the high privileges of all real universities. Wealthy citizens spend their possessions in the founding of such institutions, convinced that this is the best way of promoting public welfare. The government liberally supplies funds for scientific research, whenever its application to practical business is clear. Your system of promoting agriculture by means of experiment stations, of scientifically conducted farm-cultures, of inquiries in all parts of the world, and of collecting, introducing and trying all kinds of plants that might become useful crops, is not only admired, but even highly envied by us Europeans.

It is not without hesitation that I have accepted the honorable invitation to speak before this renowned center of learning. The ideas to which I have been conducted by my experiments are to a large degree different from current scientific belief. But I have trusted to your willingness to listen to new facts and divergent convictions, and to your readiness to acknowledge whatever spark of truth might be found in them. Unbiased by prejudice, the calm air of the university and the enthusiasm of

* Convocation address, University of Chicago, September 2, 1904.

youth seeking only truth and convinced that only pure truth can bring real progress are the judges to which I gladly submit my conceptions.

My ideas have grown slowly, and have only reached their definiteness and full development under the protection of the high principles of university freedom. I have needed nearly twenty years to develop them and to gather the evidence by means of which I hope to convince you. I kept my secret until some years ago, and worked only for myself. In this respect old universities, as ours are in Europe, have a distinct advantage over your young American institutions. With you all is sparkling and boiling, with us it is the quietness of solitude, even in the midst of a busy city. But your students and teachers are expected to show what they are doing, and to produce their results at short intervals. In Europe, on the contrary, we are trusted and left free even on this point. Hardly anybody has ever asked me what I was doing, and even those who from time to time visited my garden were content with what I could show them, without telling my real difficulties and my real hopes.

To my mind, this is a high privilege. The solution of the most intricate problems often does not require vast laboratory equipment, but it always requires patience and perseverance. Patience and perseverance in their turn require freedom from all pressure, and especially from the need of publishing early and often unripe results. Even now I would prefer to spend this hour in recounting the obligations which the doctrine of evolution is under to such men as Lamarck and Darwin. I should like to point out how they have freed inquiry from prejudice and drawn the limits between religion and science; how they have caused the principle of evolution to be the ruling idea in the whole dominion of the study of the organic world, and how this idea has been suggestive and successful, comprehensive and hopeful during a whole century of continuous research. Everywhere it is recognized to take the leadership. It has been the means of innumerable discoveries, and whole sciences have been started from it. Embryology and ontogeny, phylogeny and the new conceptions of taxonomy, paleontology of plants and of animals, sociology, history and medicine, and even the life history of the earth on which we live, are in reality in their present form the products of the idea of evolution.

Instead of telling you of my own work, I should like to sketch the part which of late the scientists of the United States have taken in this work. Mainly in two lines a rapid advancement has been inaugurated in this country. I refer to the pure university studies and the work of the agricultural stations. Highly valuable is the application of science to agriculture in the improvement of races. Each of you knows how this artificial production of races of animals and plants was one of the great sources of evidence on which Darwin founded his theory. But at his time the available evidence was only very scanty when we compare it with the numerous facts and the improved methods which now are the result of half a century's additional work. America and Europe have combined in this line, and the vast amount of facts, heaped up by numerous investigators and numerous well-equipped institutions, has produced quite a new basis for a critical review of Darwin's theory.

I have tried to combine all these too dispersed facts and to bring them together, in order to obtain a fuller proof for the main points of Darwin's conception. In one subordinate point my results have been different from those of Darwin, and it is this point which I have been invited by the

kindness of your president to discuss before you.

Darwin's theory is commonly indicated as the theory of natural selection. This theory is not the theory of descent. The idea of descent with modification, which now is the basis of all evolutionary science, is quite independent of the question how in the single instances the change of one species into another has actually taken place. The theory of descent remains unshaken even if our conception concerning the mode of descent should prove to be in need of revision.

Such a revision seems now to be unavoidable. In Darwin's time little was known concerning the process of variability. It was impossible to make the necessary distinctions. His genius recognized two contrasting elements; one of them he called sports, since they came rarely, unexpectedly and suddenly; the other he designated as individual differences, conveying thereby the notion of their presence in all individuals and at all times, but in variable degrees.

Sports are accidental changes, resulting from unknown causes. In agricultural and horticultural practise they play a large part, and whenever they occur in a useful direction, they are singled out by breeders and become the sources of new races and new varieties. Individual differences are always present, no two persons being exactly alike. In the same way the shepherd recognizes all his sheep by distinct marks, and to find two ears in a field of wheat which can not be distinguished from one another by some peculiarity is a proposition which everybody knows to be impossible. Many highly improved races of forage plants and agricultural crops have been produced by intelligent breeders simply on the ground of these always available dissimilarities. They can be selected and accumulated, augmented and heaped up, until the new race is distinctly preferable to the original strain.

In ordinary agricultural breeding, however, it is very difficult to distinguish sharply between these two principles. Moreover, for practical purposes, this distinction has no definite use. The practise of selection is nearly the same in both cases, and, besides hybridizing, with which we are not now concerned, selection is as yet practically the only means for the breeder to improve his races. Hence it came that at Darwin's time there was no clear distinction between the two types of variations, at least not to such an extent that a theory of the origin of species could confidently rely upon it.

Quetelet's celebrated law of variability was published only some years after the appearance of Darwin's 'Origin of Species.' Variability seemed until then to be free from laws, and nearly everything could be ascribed to it or explained by it. But the renowned Belgian scientist showed that it obeys laws exactly in the same way as the remainder of the phenomena of nature. The law which rules it is the law of probability, and according to this law the occurrence of variations, their frequency and their degree of deviation can be calculated and predicted with the same certainty as the chance of death, of murders, of fires and of all those broad phenomena with which the science of sociology and the practise of insurance are concerned.

The calculations of probable variations based on this most important law did not, however, respond to the demands of evolution. Specific characters are usually sharply defined against one another. They are new and separate units more often than different degrees of the same qualities. Only with such, however, Quetelet's law is concerned. It explains the degrees, but not the origin, of new peculiarities. Moreover, the degrees of deviation are subject

to reversion to mediocrity, always more or less returning in the progeny to the previous state. Species, on the contrary, are usually constant and do not commonly or readily revert into one another. It is assumed that from time to time specific reversions occur, but they are too rare to be comparable with the phenomena which are ruled by the law of probability.

A thorough study of Quetelet's law would no doubt at once have revealed the weak point in Darwin's conception of the process of evolution. But it was published as part of a larger inquiry in the department of anthropology, and for years and years it has been prominent in that science, without, however, being applied to the corresponding phenomena of the life of animals and of plants. Only of late has it freed itself from its bounds, transgressed the old narrow limits, and displayed its prominent and universal importance as one of the fundamental laws of living nature.

In doing so, however, it has become the starting point for a critical review of the very basis of Darwin's conception of the part played by natural selection. It at once became clear that the phenomena which are ruled by this law, and which are bound to such narrow limits, can not be a basis for the explanation of the origin of species. It rules quantities and degrees of qualities, but not the qualities themselves.

Species, however, are not in the main distinguished from their allies by quantities, nor by degrees; the very qualities may differ. The higher animals and plants are not only taller and heavier than their long-forgotten unicellular forefathers; they surpass them in large numbers of special characters, which must have been acquired by their ancestors in the lapse of time. How such characters have been brought about is the real question with which the theory of evolution is concerned. Now if they can not be explained by the slow and gradual accumulation of individual variations, evidently the second alternative of Darwin's original proposition remains. This was based on the sports, on those rare and sudden changes which from time to time are seen to occur amongst cultivated plants, and which in these cases give rise to new strains. If such strains can be proved to offer a better analogy to real systematic species, and if the sudden changes can be shown to occur in nature as well as they are known to occur in the cultivated condition, then in truth Darwinism can afford to lose the individual variations as a basis. Then there will be two vast dominions of variability, sharply limited, and sharply contrasted with one another. One of them will be ruled by Quetelet's law of probability, and by the unavoidable and continuous occurrence of reversions. It will reign supreme in the sciences of anthropology and sociology. Outside of these, the other will become a new domain of investigation, and will ask to be designated by a new name. Fortunately, however, a real new designation is not required, since previous to Darwin's writings the same questions were largely discussed, and since in these discussions a distinct name for the sudden and accidental changes of species into one another was regularly used. At that time they were called 'mutations,' and the phenomenon of mutability was more or less clearly distinguished from that of variability in a more limited sense. Especially in France a serious scientific conflict raged on this point about the middle of the last century, and its near relation to religious questions secured it a large interest. Jordan and Godron were the leaders and numerous distinguished botanists and zoologists enrolled themselves under their banners. They cleared part of the way for Darwin and collected a large amount of valuable evidence. Their facts pleaded for the sharp and abrupt delimitation of their

species, and asked for another explanation than that which was derived from the ordinary, slow and continuous variations.

Their evidence, however, was not complete enough to command the decision in their behalf. The direct proof of the sudden changes could not be offered by them, and they allowed themselves to be driven to the acceptance of supernatural causes on this account. Thereby, however, they lost their influence upon the progress of science, and soon fell into oblivion.

Instead of following this historical line, however, I have now to point out one of the weightiest objections against the conception of the origin of species by means of slow and gradual changes. It is an objection which has been brought forward against Darwin from the very beginning, which has never relented, and which often has threatened to impair the whole theory of descent. It is the incompatibility of the results concerning the age of life on this earth, as propounded by physicists and astronomers, with the demand made by the theory of descent.

The deductions made by Lord Kelvin and others from the central heat of the earth, from the rate of the production of the calcareous deposits, from the increase of the amount of salt in the water of the seas, and from various other sources, indicate an age for the inhabitable surface of the earth of some millions of years only. The most probable estimates lie between twenty and forty millions of years. The evolutionists of the gradual line, however, had supposed many thousands of millions of years to be the smallest amount that would account for the whole range of evolution, from the very first beginning until the appearance of mankind.

This large discrepancy has always been a source of doubt and a weapon in the hands of the opponents of the evolutionary idea, and it is especially in this country that much good work has been done to overcome this difficulty. The theory of descent had to be remolded. On this point conviction has grown in America during the last decades with increasing rapidity. Cope's works stand prominent amongst all, and much valuable discussion and evidence has been brought together.

The decision, however, could only be gained by a direct study of the supposed mutations, but no distinct cases of mutability were at hand to provide the material. Discussions took the place of inquiry, and a vast amount of literature has broadly pictured all the possibilities and all the more or less plausible explanations without being able to give proof or disproof.

In this most discouraging state of things I concluded that the only way to get out of the prevailing confusion was to return to the method of direct experimental inquiry. Slow and gradual changes were accepted to be invisible or nearly so; mutations, however, would be clear and sharp, although of rare occurrence. I determined to start on a search for them, and tried a large number of species, partly native forms of my own country and partly from different sources. Each of them had to be tried as to its constancy, and large numbers of seedlings had to be produced and compared. The chance of finding what I wanted was of course very small, and consequently the number of the experiments had to be increased as far as possible.

Fortune has been propitious to me. It has brought into my garden a series of mutations of the same kind as those which are known to occur in horticulture, and moreover it has afforded me an instance of mutability such as would be supposed to occur in nature. The sudden changes, which until yet were limited to the experience of the breeders, proved to be accessible to direct experimental work. They can not yet in truth be produced artificially,

but, on the other hand, their occurrence can be predicted in some cases with enough probability to justify the trial. Color changes in flowers, double flowers, regular forms from labiate types, and others have been produced more or less at will in my garden, and under conditions which allowed of a close scientific study. The suddenness of the changes and the perfection of the display of the new characters from the very beginning were the most striking results.

These facts, however, only gave an experimental proof of phenomena which were historically known to occur in horticulture. They threw light upon the way in which cultivated plants usually produce new forms, but between them and the real origin of species in nature the old gap evidently remained.

This gap, however, had to be filled out. Darwin's theory had concluded with an analogy, and this analogy had to be replaced by direct observation.

Success has attended my efforts even on this point. It has brought into my hands a species which has been taken in the very act of producing new forms. This species has now been observed in its wild locality during eighteen years, and it has steadily continued to repeat the phenomenon. I have brought it into my garden, and here, under my very eyes, the production of new species has been going on, rather increasing in rate than diminishing. At once it rendered superfluous all considerations and all more or less fantastical explanations, replacing them by simple fact. It opened the way for further investigations, giving nearly certainty of a future discovery of analogous processes. Whether it is *the* type of the production of species in nature or only *one* of a more or less large group of types can not yet be decided, but this is of no importance in the present state of the subject. The fact is that it has become possible to see species originate, and that this origin is sudden and obeys distinct laws.

The species which yielded these important results is an American plant. It is a native of the United States, and nearly allied to some of the most common and most beautiful among the wild flowering plants of this country. It is an evening primrose, and by a strange but fortunate coincidence bears the name of the great French founder of the theory of evolution. It is called 'Lamarck's evening primrose,' and produces crowns of large and bright yellow flowers, which have even secured it a place amongst our beloved garden plants.

The most interesting result which the observation and culture of this plant have brought to light is a fact which is in direct opposition to the current belief. Ordinarily it is assumed that new species arise by a series of changes in which all the individuals of a locality are equally concerned. The whole group is supposed to be modified in a distinct direction by the agency of the environmental forces. All individuals from time to time intercross, and are thereby assumed to keep equal pace in the line of modification, no single one being allowed to go distinctly ahead of the others. The whole family gradually changes, and the consequence would be that the old form disappears in the same degree as the new makes its appearance.

This easy and plausible conception, however, is plainly contradicted by the new facts. There is neither a gradual modification nor a common change of all the individuals. On the contrary, the main group remains wholly unaffected by the production of new species. After eighteen years it is absolutely the same as at the beginning, and even the same as is found elsewhere in localities where no mutability has been observed. It neither disappears nor dies out,

nor is it ever diminished or changed in the slightest degree.

Moreover, according to the current conception, a changing species would commonly be modified into only one other form, or at best become split into two different types, separated from one another by flowering at different seasons, or by some other evident means of isolation. My evening primrose, however, produces in the same locality, and at the same time, from the same group of plants, quite a number of new forms, diverging from their prototype in different directions.

Thence we must conclude that new species are produced sideways by other forms, and that this change only affects the product, and not the producer. The same original form can in this way give birth to numerous others, and this single fact at once gives an explanation of all those cases in which species comprise numbers of subspecies, or genera large series of nearly allied forms. Numerous other distinct features of our prevailing classification may find on the same ground an easy and quite natural explanation.

To my mind, however, the real significance of the new facts is not to be found in the substitution of a new conception for the now prevailing ideas; it lies in the new ways which it opens for scientific research. The origin of species is no longer to be considered as something beyond our experience. It reaches within the limits of direct observation and experiment. Its only real difficulty is the rarity of its occurrence; but this, of course, may be overcome by persevering research. Mutability is manifestly an exceptional state of things if compared with the ordinary constancy. But it must occur in nature here and there, and probably even in our immediate vicinity. It has only to be sought for, and as soon as this is done on a sufficiently large scale the study of the origin of species will become an experimental science.

New lines of work and new prospects will then be opened, and the application of new discoveries and new laws on forage crops and industrial plants will largely reward the patience and perseverance required by the present initial scientific studies.

HUGO DE VRIES.

SCIENTIFIC BOOKS.

The Direction of Hair in Animals and Man. By WALTER KIDD, M.D., F.Z.S. London, Adam and Charles Black. 1903.

Dr. Kidd's recent work on the 'Direction of Hair in Animals and Man' is to a certain extent a compilation of his numerous previous works on the same general topic, to which is added a considerable amount of theoretical discussion. It is not intended to be an exhaustive treatment of the subject, but rather a discussion of those particular conditions which seem to substantiate the doctrines of Lamarck.

Three principles governing hair direction are pointed out:

1. That the simple and uniform hair slope of primitive mammals (*i. e.*, a general slope from cephalic toward caudal extremity of the body and from the proximal toward the distal end of the limbs) is not easily departed from in the individual development of any animal.

2. That there are certain modifications in this primitive arrangement that are due to morphological changes in the animal exhibiting them.

3. That all of the remaining phenomena of hair direction are to be explained by the action of mechanical forces on the surface of the body.

The first of these principles receives a brief discussion in which it is stated that the primitive hair slope corresponds to the direction of overlapping of the scales, which it is assumed covered the bodies of the earliest mammals. This law accounts for the slope of the major part of the hairy covering of any mammal. The existence of such a condition is

considered an adaptation and is attributed to natural selection.

The second law receives little explanation or discussion aside from a few illustrations.

It is upon the third law that the attention of the author is concentrated, since, obviously, the facts from which this law is deduced have direct bearing upon Lamarckism.

Those regions of the body of a mammal which are peculiarly open to contact with opposing surfaces or are under the special influence of certain active habits of a particular animal form are designated as 'critical areas.' They are the regions in which the action of the third law may be seen and they exhibit, to a greater or less extent, deviations from the primitive hair arrangement. Of such areas there are eleven, enumerated as follows: 'the naso-frontal, pectoral, cervical, axillary (post-humeral), inguinal, spinal, extensor surface of the ulna, ventral and lateral surfaces of the abdomen, extensor surface of the thigh, gluteal, and the side of the flank.' The deviations from the primitive hair slope which occur upon these areas are classified as (1) reversed areas of hair, (2) whorls, featherings and crests, (3) tufts.

A reversal involves a distinct opposition to the primitive hair direction and is attributed to the effect of contact with the ground or with other external opposing surfaces. Reversal is seen on the snout of the lion, for example, and over a still greater area on the nasal region of the horse and its allies. In these cases the hair, instead of sloping in the supposed primitive direction from the tip of the snout toward the top of the head, as illustrated by the red deer, slopes *toward the snout* from a point below the level of the eyes in the lion and between the eyes in the horse. This peculiarity of hair direction is explained as correlated with the angle at which the head is carried, and is attributed to the fact that air and other agents with which the face comes in contact oppose the primitive hair slope by stroking the hair toward the tip of the nose.

Most mammals spend a large proportion of their time in resting, and to the various positions employed much of the reversal of hair direction is due. This contact with the ground or with some portion of the body in the habitual sitting or recumbent position accounts for reversals upon: (1) the pectoral region of practically all mammals except ungulates, (2) the extensor surface of the ulna in carnivores, certain ungulates and primates, including man, (3) the lateral aspect of the abdomen in nearly all carnivores and ungulates, and (4) the extensor surface of the thigh in many species. As the reversed hair direction upon the extensor surface of the ulna in man has hitherto been considered an important vestigial character, this new explanation of it is of especial interest.

The second named deviation from the primitive hair direction, viz., the whorl, involves the divergence of hair from a point and may be accompanied by the phenomenon of a feathering. In those cases in which the feathering occurs two divergent hair streams lead from the whorl, curve on each side into the general hair direction of the region and often terminate sharply by a crest or ridge where the opposing hair stream is met. Whorls and their attendant phenomena are attributed by Kidd to 'strong, very frequent, divergent muscular action' in the region over which the whorl occurs; but, although he shows in numerous cases an extremely interesting correspondence between the location of the whorl, feathering and crest, and the divergent arrangement of the underlying muscles, he unfortunately omits to explain the mechanical process by which such divergent muscular action could affect hair direction. We naturally infer that the force exerted is applied to the hair follicle, but if this is the case, and it could hardly be otherwise, the effect of the pull would be to turn the external portion of the shaft, not in the same, but in the opposite direction. It is thus somewhat difficult to see how the action of divergent forces upon the follicles could result in the divergence of the external portions of the hairs, *i. e.*, in the formation of a whorl.

The most abundant illustrations of the whorl are drawn from the domestic horse, the highly developed locomotive habits of which render certain regions exceedingly subject to

very frequent, strong, opposing muscular tractions. In both the frontal and pectoral regions of the horse the whorl is said to be absolutely constant, and in the latter region it is accompanied by a feathering and crest, thus involving a reversal of the hair over a portion of the pectoral area. In other mammals, even those so closely related to the horse as the mule and ass, pectoral whorls are of much less frequent occurrence. The cervical, axillary and inguinal regions of the horse show whorls with a greater or less degree of constancy, and statistics indicate a correspondence between the development of locomotive power, on the one hand, and both the degree of perfection and the constancy of occurrence of these whorls, on the other, a correspondence the significance of which is of course emphasized by their infrequent occurrence in related forms of less highly developed locomotive power. Thus Kidd looks upon these whorls as actual 'pedometers,' and by way of emphasizing their significance draws a striking comparison between the horse and the zebra, which rarely exhibits any whorls. "These two animals carry about on their hairy coverings indubitable records of their habits and those of their near ancestors."

To the action of the *panniculus carnosus* of the back in shaking off flies and other insects are attributed the whorl and feathering which occur upon the spinal area of the lion, ox, giraffe and larger antelopes. Statistics are given to show the correlation of this phenomenon with a heavy mane and long tail, devices for removing insects from other regions.

In the gluteal region of some animals, particularly certain breeds of dogs, whorls are described which, contrary to the principles previously set forth in defining a whorl, are attributed to the *passive influence of external pressure* resulting from the frequently assumed sitting posture. In none of the cases which happen to have come under my own observation, however, does this feature involve a *divergence* of hair (the essential element of Kidd's whorl) the figure being distinctly a *convergent spiral* (in Voigt's terminology a 'convergierende Wirbel') corresponding more closely, as is shown later, to Kidd's definition of a tuft. Moreover, the sitting position of dogs is, so far as I have observed it, a crouching upon the hind legs, often with the ischial prominences hardly in contact with the ground, the weight being borne mainly upon the tarsus and foot.

Tufts, which of all the critical area phenomena are the most rare, involve always a convergence of the hair towards a point. Among the cases cited are those of the rare gluteal tuft of the horse said to be caused by the friction of the kicking-strap, and the more common gluteal tuft of the domestic ox, attributed to the habit of flicking the tail for the purpose of removing flies. There seems to be a decided discrepancy between these illustrations, with their explanations, and the general statement (p. 22) that tufts are the result of 'frequent, converging muscular action.' Even the tufts which are mentioned as occurring in the inguinal region in horses, although attributed to the action of the great oblique muscle, are not shown to be due to *convergent* muscular action.

These two regions, viz., the gluteal and inguinal, are the only ones upon which Kidd has found tufts. He has, however, overlooked several others of common occurrence, both on the horse and on other domestic animals. Such, for example, is the very common olecranal tuft which is well shown by short-haired dogs and is of practically constant occurrence in the human fetus.

A separate chapter is devoted to the consideration of the critical areas of man because man is the species the habits of which are the most completely known. Kidd finds *none of the peculiarities of hair direction in man dependent upon locomotive activity.* The numerous deviations from the primitive hair direction are, therefore, attributed not to motor phenomena, but rather to the influence of external forces.

The very ancient habit of sleeping or resting upon the back or side with the head and shoulders slightly elevated upon some sort of pillow is said to be responsible for many of man's peculiarities of hair direction. Among these are the partial reversal upon the deltoid

region and upon the lateral regions of the upper portion of the back, conditions found in no other species. These results are attributed to the tendency of the body to slide down from the pillow. The distinct lines of parting along the sides of the body on the ventral surface are thought to be possibly attributable to the pressure of the arm as it rests upon the body in sleeping, while the whorl which frequently occurs in this line is, contrary to the general principle earlier set forth as accounting for whorls, attributed to the pressure of the elbow.

The various methods of dressing the hair are said to account for the considerable variety of hair directions on the front of the scalp and the back of the neck.

The pressure of the clothing over the chest involved in respiratory movements is brought in to explain the reversal of hair above the 'sternal angle,' while the sudden diminution of hair at the level of the tops of the shoes is cited as an illustration of disuse and is attributed to the constant pressure of the shoe below that level.

In spite of the fact that the habits of man are so well known, it must be admitted that Kidd's discussion of the critical areas of man is the least complete and satisfactory portion of his book. Not only are some of the explanations submitted frankly given as mere conjectures, but many important phenomena are wholly ignored. For example, with the exception of the whorl upon the crown of the head, those which sometimes occur upon the lateral hair-parting of the trunk, and a pair in the pectoral region at the level of the sternal angle, there is no recognition of the many 'Wirbel' (Voigt's term) either divergent, *i. e.*, corresponding to Kidd's whorl, or convergent (Kidd's 'tufts') which have been so carefully worked out by Voigt and others and shown to be of such frequent, and in some regions of such constant occurrence upon the human body. Moreover, some of these phenomena correspond exactly in location to those to which Kidd attaches so much importance in his discussion of lower mammals. The axillary divergent Wirbel (a whorl), for example, has been found to be of practically constant occurrence in man. Kidd, in discussing the axillary whorl of the horse, says (p. 39) that in this region 'the more passive influences of pressure on the hair or friction are not represented, but it is an area with considerable opportunity for the active influence of strong, divergent muscular action to manifest itself.' He adds: 'Whorls in this region are so rare outside of the ungulate order that after an extensive search for it in other hair-clad mammals, I have been only able to find two instances in which it was present, and then only in a rudimentary form.' The cases cited are both dogs.

This statement and the fact that Kidd attributes none of the peculiarities of hair direction of man to motor phenomena, show that he was probably unaware of the existence of this, and possibly also of many other whorls and tufts upon the body of man. If aware of their occurrence, then there is a serious and very unfortunate discrepancy in his explanations, since these two phenomena are in the early part of the book distinctly attributed to divergent and convergent action, respectively, of underlying muscles.

After the discussion of critical areas in lower animals and in man, Kidd gives by way of summary a chapter on the 'Delimitation of Hair Tracts.' These hair tracts are shown to be either (1) primitive or (2) acquired, (*a*) by morphological changes or (*b*) by use or habit. The whole primitive hair slope is compared to the course of a river which continues unchanged until some obstacle interferes with its accustomed flow. These obstacles in the case of the hair stream are the mechanical forces which act upon the growing hair opposing the primitive direction of growth. If the action is sufficiently constant the course of the stream is changed. Thus the hairy coat of a mammal bears an indubitable record of the forces to which it has been exposed.

The otter is cited as a form in which the hair tracts are wholly primitive, while the ox, horse and especially man show that with increasing complexity of form and habits of life come increasing mechanical disturbance of the primitive condition and consequent

increasing complexity of hair slope. With reference to man the statement is made that man has 'acquired, by some means or other, and transmitted, a very remarkable series of changes both from the primitive and from the Simian type.'

Those hair tracts which have been acquired by 'morphological changes' are described as merging somewhat into those acquired through the effect of use or habit (*i. e.*, mechanical forces), 'the frontiers between the two being, of course, somewhat vague.' In fact, there is no criterion whatever given by means of which one may know which deviations from the primitive direction are due to these 'morphological changes,' the whole distinction being, so far as I have been able to determine, a purely arbitrary one.

Kidd's theoretical discussion involves the following line of argument:

Deviations from the primitive direction of hair can not, even in the case of long-haired forms (with the single possible exception of the extensor surface of the ulna of certain of the Anthropoidea) be considered an adaptation. These deviations can, therefore, have no selective value and can not, like the primitive direction, be accounted for by any process of selection, natural, sexual or germinal.

The correlation between the deviations from the primitive direction and the mechanical forces exerted upon certain areas of the body indicates that these deviations are due wholly to such forces. Deviation from the primitive direction is, however, not easily produced and occurs only when there is a decided preponderance of force in a single direction.

The existence of these deviations in fetuses and in the new-born indicates their inheritance. Hence in the realm of hair direction the Lamarckian principle of the inheritance of acquired characteristics is established.

Kidd claims for his views no opposition whatever to Darwinism. On the contrary, his course of reasoning seeks to establish a fusion between the two great principles of natural selection and use-inheritance. The issue is, however, distinctly with Weismannism, which claims the non-inheritance of acquired characters as an integral part of its theory.

It is obvious that Kidd has laid before us a large number of extremely interesting facts showing an indisputable correlation between the direction of hair and the mechanical pressure from various causes, exerted upon the skin. His explanation of this correlation can, however, hardly be accepted *as final* at the present stage of the investigation, and the following criticisms are offered merely as suggestive of further research which the field demands:

1. There is no recognition in Kidd's discussion of a possible difference between the direction of the external portion of the hair and that of the follicle. Before any of the variations in hair direction upon the human scalp can, for example, be logically attributed to methods of parting and dressing the hair, it should be shown that a change in the direction of the external, more or less wiry portion of the hair produces a change in the direction of the follicle. In the case of the sloth, also, it is unquestionably a fact that in obedience to gravitation the long hair hangs down, in the habitual inverted position of the body. It would be exceedingly interesting, and, for the validity of Kidd's argument, of absolute importance to know (1) whether the follicles themselves have this same direction and (2) whether this direction occurs in the fetus. No one, indeed, will deny the temporary action upon hair of gravitation or any other external force which may be applied to it; but to show that these forces acting upon the long external hair produce any real change in the direction of the growing portion of the hair, which alone constitutes hair direction as used morphologically, is a necessary link in the chain of reasoning which seeks to prove that congenital hair direction of an animal can be attributed to mechanical forces acting upon the external portion of the hair of its ancestors.

The failure to recognize the possible difference between the superficial condition and the real hair direction may be further illustrated by Kidd's treatment of the mole. He says: "The skin of this animal possesses that unusual quality of hair resembling velvet and has no fixed slope of hair, as is the case in

most other animals, for the simple reason, it may be presumed, of its burrowing habits." I have found, however, in my own study of moles that if the hair is cut close to the body there is displayed in every region a decided hair slope, showing much individual variation and many whorls, tufts and other phenomena such as Kidd elsewhere considers important. Plainly here there is no correspondence between the external or apparent condition and the true hair direction. An equally careful examination of each long-haired form should be made before any definite statement as to its hair direction is given, since it is possible that even an animal exhibiting superficially the so-called primitive hair slope might show in the direction of the follicles unsuspected deviations from this.

2. Although one of the data with which Kidd prefaces his discussion is 'that the direction of hair can be modified in the life of an individual animal,' he gives no account of the actual observation of such changes. He says, "This is obviously the case in the head and face of man and may be assumed to be so in lower animals though not easily shown in particular cases." If this datum be true, however, and if the hairy coat of a horse is so exact a 'pedometer' as Kidd believes it to be, it should be easily possible during the training of a colt for the race-course and its subsequent career to observe actual changes of hair direction, and his conclusions will carry greater weight when such observations have been made. Unfortunately the few unconscious experiments which are cited as having been performed by man are largely negative in their results.

3. With regard to the inheritance of peculiarities of hair direction, much light would probably be thrown upon the subject by the study of conditions in several successive generations. In the case of rapidly breeding animals (*e. g.*, white rats, which I have found show much variation in hair directions of certain regions) such observations might easily be made, and in many cases three generations, at least, of the human species would be available.

4. As already indicated, there is no explanation of the *process* by which the divergent traction of underlying muscles produces its supposed effect upon hair direction. The dynamic relation between such points of divergence and whorls is yet to be explained.

5. The very stronghold of Kidd's argument seems to be the assumed fact that practically none of the modifications of the primitive hair slope are adaptive. Is it not possible, however, that with a structure so complicated, so manifold in its functions, and, withal, at present so little known as the skin, even a short hairy covering may possess as yet imperfectly understood functions? Our present state of knowledge of this subject is, at least, not so complete that we are warranted in basing an argument upon the assumption of the lack of function of any particular hair direction.

Furthermore, even granting that a given hair direction is determined in response to mechanical causes, may not this very power of response on the part of the growing tissue be considered an adaptation and, therefore, of selective value?

On the other hand, ruling out any possibility of a selective process as accounting directly or indirectly for peculiarities of hair direction, Kidd fails to show any reason why these may not be simply spontaneous variations which, not held by a selective process to a definite course of evolution, are running riot, as it were. The very large amount of individual variation which Kidd himself acknowledges and which has been described by Voigt for the human species is itself an indication of the plausibility of such an explanation.

6. Kidd's treatment of the entire subject presents certain inconsistencies and discrepancies, some of which have already been pointed out. Probably the most serious of these is the lack of harmony between his preliminary statement of the cause of whorls and tufts as due to motor phenomena and his subsequent explanation of many of them as due to external pressure.

7. Perhaps the most serious fault of the whole work is the arbitrariness with which the lines are drawn distinguishing between the three principles governing hair direction.

With regard to the first of these, which assumes a primitive caudalward direction of the hair, it may be suggested that a careful study of the direction of the overlapping of scales not only in the few mammals in which these structures persist but in other scaly vertebrates, particularly reptiles, may show that the arrangement of scales upon which this primitive hair direction is based is not so simple a one as it is here assumed to be. My own investigation of this subject, the results of which I hope later to publish, has shown me that scale arrangement may involve points and lines both of convergence and of divergence.

With regard to the second principle, that of hair directions due to 'morphological changes,' I have already confessed an inability to understand what phenomena this principle accounts for or to determine upon what basis any particular modification of the 'primitive hair direction' would be ascribed to it. To be sure, the author says distinctly that he makes no attempt to discuss this principle. By omitting, however, to at least clearly define it he exposes himself to the criticism of having selected from the observed phenomena of hair direction those for which he could discover or conjecture a mechanical cause, and of having relegated to this nondescript class all other phenomena except those which are included under the supposed primitive direction.

It is, indeed, inconceivable that, provided mechanical forces can produce inheritable changes in hair direction, the hairy coat (or in fact, the scaly coat) of a mammal should at any stage of its evolution have been free from the influence of such mechanical forces. In other words, to explain a primitive hair direction as to any less extent due to the action of mechanical forces than are the deviations from it is illogical. Thus while Kidd's classification of hair tracts is a useful one for purposes of discussion, to base such a classification upon a distinct difference in cause (*i. e.*, natural selection, morphological change and use inheritance) is to employ arbitrary distinctions.

We are indebted to Dr. Kidd for reviving an especially fine field, not so much for theoretical discussion as for scientific research which should eventually yield many data for such discussion. What is particularly needed at present is not a selection of facts to prove Lamarckism, Darwinism, Weismannism or any other theory, but a laborious, careful, complete working out of the entire field of hair directions, in as many forms as possible, together with a study of scale arrangement and the relation of scales to hair, to determine, if possible, the primitive conditions. Science has no place for dogmatic statement, and no hypothesis, however satisfactory when considered in view of one set of facts, should be protected at the sacrifice of a knowledge of any other facts which research may bring to light. Every scientist will argue with Dr. Kidd that 'the scientific attitude is that of judging a large series of facts on their own merits, and according to the weight of evidence, even if it tend against a widely accepted hypothesis!'

INEZ L. WHIPPLE.
SMITH COLLEGE, NORTHAMPTON, MASS.
August 1, 1904.

DISCUSSION AND CORRESPONDENCE.

ON CITING THE TYPES OF NEW GENERA.

IT seems worth while to call attention to the desirability of formally transferring the species upon which new genera are based, when these species have been earlier described in other genera. It seems a very trifling matter, but a bibliographer has to cite what he finds in print, and that only; and as a result of the present practise of many zoologists, the actual combination of a new generic name with its type species often occurs, not at the place where the genus is proposed, but accidentally, as it were, in some other easily overlooked place. To illustrate my meaning, I may refer to a couple of very recent instances:

Gilbertella, Eigenmann, Smiths. Misc. Coll., Vol. 45, p. 147. (1903.)
"*Type.—Anacyrtus alatus,* Steind."

Dimmockia, Ashmead, Mem. Carnegie Mus., Vol. 1, p. 357. (1904.)
"*Type.—Eulophus incongruus,* Ashm."

It seems to me that the proper way would have been to write for the first, type, *Gilbertella alata* (*Anacyrtus alatus,* Steind.), and the

second, type, *Dimmockia incongrua* (*Eulophus incongruus*, Ashm.).

T. D. A. Cockerell.

VARIÆ AUCTORITATIS.

To the Editor of Science: The early authorities alluded to by Mr. Eastman are always of interest and more so than modern men seem disposed to admit, hence it is of genuine value to run down his reference to 'Origines.'

In the first place, it should be obvious that the form 'Origines' could not come from *Origen*, as Mr. Eastman suggests.

It seems likely that Mr. Emmons, or *his* author, intended to quote the 'Origines' of M. Porcius Cato (Cato Major), who died B. C. 149; and of which work in two books fragments remain.

I have not the work by me, but believe there is something of the kind quoted from it in a medieval Latin writer, Lullius, if my memory serves me right, or it may have been Albertus Magnus, a work of whose is bound up with an early edition of a treatise by Lully.

The study of the early writers, difficult as it is from lack of knowledge of the meanings of their technical terms, is most unwarrantably neglected; and for the same reason their attainments are ignorantly sneered at. The old idea that Galen thought the arteries carried air, repeated from text-book to text-book, is a case in point, easily disproved by any one with a knowledge of ancient phraseology, from Galen's writings.

Much ancient tradition thus passes out of our ken, to be dug out by the solitary explorer here and there, but to vanish for ages or longer from the sum of practical human knowledge.

Geo. Chas. Buchanan.

Mora, Minn.,
August 17, 1904.

SPECIAL ARTICLES.

INTRUSIVE BURIALS IN ANCIENT MOUNDS.

The custom, which was formerly practised by various tribes throughout the Mississippi valley, namely, that of utilizing the ancient mounds as places of burial for their dead, is even now followed by some Ojibways in Minnesota. The Ojibway village of Sa-ga-wah-mick, which is located on the south shore of Mille Lac in the state of Minnesota, is situated in the midst of a group of some sixty mounds —many of these being seven or eight feet in height. According to the Ojibway tradition, which is also verified by historical facts, the country adjacent to Mille Lac was formerly occupied by the M'de Wakan Sioux who were driven out by the Ojibways about the year 1750, or, according to the Ojibway's story, 'five generations ago.'

The Indians at Sa-ga-wah-mick recognize the mounds as being artificial, and claim they were erected by the Sioux over the remains of their dead. Several facts tend to justify the belief that such may be the true explanation of their origin. Fragments of pottery which I found near the original surface in a mound about four feet in height were similar in structure and design to pieces which were discovered upon the surface of a village site, near by, and which is known to have been the site of a Sioux settlement before the country was occupied by the Ojibways. The peculiar form of burial discovered in the mounds was certainly entirely different from any known to have been practised by the Ojibways and would conform with the Sioux habit of removing the flesh from the bones before the latter were interred. In one mound which I opened were four burials. The arm and leg bones of each skeleton had been bunched separately, upon each was placed a skull, all rested upon the original surface and the mound of earth had been formed over them. In addition to these only one small bone was found in the mound.

The Ojibway believing these mounds to have been erected by the Sioux, now utilize them as burial places for their own dead.

On the sides and top of one of the largest mounds at Sa-ga-wah-mick were counted thirteen comparatively recent graves, all having the box-like cover of hewn logs—so typical of Ojibway burials—upon one end of which was cut the totem of the deceased. Around the summits of several mounds a picket fence had been erected to surround and thereby protect the graves.

Thus we find in a remote Ojibway village

the survival of a custom which was once practised throughout the Valley of the Mississippi —that of utilizing the ancient mounds as places of burial.

In many mounds which have been examined in the central and southern section of the valley, interments have been discovered only two or three feet below the present surface of the mounds. A notable instance of this sort occurred at the time of the destruction of the large mound which formerly stood in the city of St. Louis. In 1869 when the mound was removed, human remains were found about three feet below the surface near the north end.* Stone graves were also found upon the summit of the same mound, a group of five having been examined by members of the Long Expedition as early as 1819.†

According to a statement made by Conant, the large mound must have been used by the Indians as a place of burial, as late as 1819 or the same year it was seen and described by the Long party.

"This mound, as is well known, was used by the Indians as a burial place, and only about sixty years since, it was visited by a small band, who disinterred and carried away the bones of their chief, who had been buried there."‡

At a meeting of the Ethnological Society in January, 1861, E. G. Squier described a burial which had recently been discoverd near the summit of a small mound near Cahokia, opposite St. Louis, and stated "that the position of the skeleton in the mound would lead him to infer that it was of comparatively recent deposit. His experience was that the true remains of the mound builders were generally to be found at the bottom of the mound, immediately under its apex."

Such a conclusion would apply to the mounds at Mille Lac; the 'true remains of the mound builders' are found at the bottom of the mound on the original surface, while the secondary or intrusive burials are made by the Ojibways.

D. I. BUSHNELL, JR.

CAMBRIDGE, MASS.,
July 22, 1904.

* Conant, 'Footprints of Vanished Races,' 1879, p. 41.

† 'Expedition from Pittsburg to the Rocky Mountains,' Phila., 1823, Vol. I., p. 64.

‡ Conant, p. 41.

§ *Bulletin of the Ethnological Society*, Vol. I., p. 25, January, 1861.

CURRENT NOTES ON METEOROLOGY.

A WORLD-WIDE BAROMETRIC SEE-SAW.

To *Nature* for June 23, Dr. W. J. S. Lockyer contributes an article under the above title, in which the results of recent studies by Sir Norman Lockyer and himself are embodied. Two pressure variation types were selected, that over India and that at Cordoba, and the pressure curves of other places were compared with these two type curves. When any pressure curve extending over several years showed an excess pressure at those epochs when the Indian pressure curve was in excess, it was classified as similar to the Indian type, and represented by a +. If more like the Indian curve than the Cordoba curve, but not quite the exact counterpart of India, it was marked + ?. Similarly, pressure curves like Cordoba were classified as —, and those more like Cordoba than India, as — ?. Other cases, difficult to classify satisfactorily, were marked ± ? or ?. The signs of the different types of pressure variation were then entered on a map of the world, and the two main regions were separated by neutral lines. It is interesting to note that the two neutral lines are fairly symmetrical to one another. Both lines apparently cross the equator at antipodal points, and both appear to have a similar trend in north and south latitudes. The indication is that a general law exists with regard to pressure changes which occur simultaneously in these two extensive regions of the globe, the neutral lines forming a fulcrum about which see-saws of pressure from one region to another take place. Professor Bigelow, of the U. S. Weather Bureau, has reached conclusions along the same line of investigation which are in the main similar to those here discussed. The importance of these studies is in connection with the possible long-range forecasting of the future, for it is probable that regions which are the reverse of one another as regards secular pressure variations should have opposite kinds of abnormal weath-

er, while those over which the same type of pressure variation exists should have weather of an abnormal but similar nature.

VERTICAL TEMPERATURE DECREASE UP TO 10 KILOMETERS.

A PAPER on the vertical decrease of temperature up to altitudes of 10 kilometers, as determined by balloon observations, was read by Hann before the Vienna Academy of Sciences on April 21, 1904. The object of the investigation, the results of which were presented in this report, was to ascertain whether the annual march of the temperature at great altitudes in the free air can at present be determined with fair accuracy on the basis of the observations already made during balloon ascents. The data employed were obtained on 150 ascents up to seven kilometers, and on 125 up to heights between seven and ten kilometers. Among the most interesting of Hann's results are those which concern the rate of decrease of temperature vertically in cyclones and anticyclones in winter and summer. These agree with Hann's conclusions based on the Sonnblick observations up to three kilometers, and with the results obtained by de Bort for greater altitudes. The vertical decrease of temperature in the lower air is slower in anticyclones than in cyclones, but at greater altitudes the relations change. The lowest temperatures at great heights are found in anticyclones. In the lower air, and above eight kilometers, the minima are warmer, and in the intermediate strata the maxima are warmer. The excess of temperature in the anticyclones reaches at its maximum about 9° in the stratum between two and three kilometers. Similar differences were previously found from the Sonnblick observations. The general mean between one kilometer and ten kilometers gives an excess of temperature for the anticyclonic air, but definite conclusions must be postponed until the publication of de Bort's results.

WEST INDIAN HURRICANES.

As usual during the tropical cyclone season, the 'Pilot Chart of the North Atlantic' for July contains an account of West Indian Hurricanes, by James Page (reprinted from Hydrographic Office Publication No. 86, Gulf of Mexico and Caribbean Sea, Vol. I., 5th edition, 1901). This is an excellent brief account of the most important facts regarding season and frequency; origin and development; area and depth; direction of the wind and bearing of the storm center; distance of the center; weather changes during the approach of a tropical cyclone; the motion of the storm center and the shifts of the wind; and maneuvering. Four figures show: (I.) the generalized track and the direction of the inflowing winds; (II.) tracks of the more important hurricanes during the ten-year period 1890–1899; (III.) barometric pressure and wind at Havana during the hurricane of October 19, 1876; and (IV.) positions in which vessels caught in a hurricane should 'lie to.' Extra copies of this discussion on West Indian hurricanes may be obtained on application to the hydrographer, Navy Department, Washington. The August 'North Pacific Ocean Pilot Chart' has a similar discussion of typhoons.

CLIMATE OF EGYPT.

THE 'Meteorological Report for the Year 1901,' published by the Survey Department, Public Works Ministry, Cairo, has recently been received (Cairo, 1903). The usual international tables are given for seven stations in Egypt and six in the Sudan, including Omdurman, Wadi Halfa and Suakin. In a personal letter to the compiler of these notes, Captain H. G. Lyons, director-general of the Survey Department of Egypt, writes as follows: "I have this time published large diagrams of the daily observations, and it is interesting to see the prompt effect of a Mediterranean depression passing near our African coasts. I hope that a note on the Khamsin winds will be published this year. These are not a special spring effect, as has frequently been said, but are our southerly winds which we may have at any time, though their intensity and sand-carrying power is greatest in May."

R. DEC. WARD.

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*THE NATIONAL ANTARCTIC EXPEDITION.**

IT is anticipated that the National Antarctic Expedition may reach these shores one day during next week. Since its departure in August, 1901, the expedition has passed two years and two months within the Antarctic Circle, and has achieved results which admittedly place it in the very first rank of Polar expeditions. The return of the *Discovery* will complete another entry in the long roll of exploring enterprises for which, as well as for her warlike victories, the British navy has so long been distinguished. Much of the success of the expedition is due to the rare gifts for command displayed by Commander Robert Scott amid the trying conditions of life in the Antarctic; but the officers and men also deserve warm praise for their devoted loyalty and zeal. All alike have done splendid work, and all alike have earned the thanks of their countrymen.

The task assigned to Commander Scott and his companions in the official instructions was one which in any case was bound to make large demands on the courage and skill of all concerned. To spend one winter in the far south would have been no mean achievement. But the expedition has done more than this. Circumstances necessitated the passing of a second winter in the Antarctic; and the work of the second winter and the second traveling season, while doubling the results, has more than doubled their scientific value. The expedition involved hardships of no ordinary kind, perils on which the members of the expedition will be the last to dwell, difficulties which only Polar men can appreciate; but the reward has been great. Extensive geographical discoveries have been made, and accurate surveys completed. These are certainly worthy of all the attention they have attracted, but they form only a part of the achievement. The discovery of a fossil flora in the far south is of itself an event of great scientific importance. The biological collections are unique; for they are the only collections that have been made 700 miles to the south of the Antarctic Circle. The careful meteorological records are greatly enhanced in value by their extension over a couple of years. The magnetic observations recorded at sea, as well as those registered on the Antarctic land, will certainly be of very special interest. Those taken with the Eschenagen instruments form a continuous record comprising 700 magnetograms. It is of course premature to anticipate final results, though there are several fascinating problems awaiting solution; but it may be mentioned that when, on November 1, 1903, a magnetic storm prevailed from Potsdam to New Zealand, the magnetic disturbances observed at the *Discovery's* winter quarters were unusually numerous and violent. The value of the observations for declination, inclination and total force during the memorable journey over the great ice barrier, when a record southing was attained, is very great, because the observations were secured under conditions quite free from local disturbances. The results will, therefore, be specially useful in fixing the position of the magnetic pole. Other branches of physical work, such as the taking of observations in connection with the force of gravity, seismic disturbances and atmospheric electricity, were steadily pursued throughout both years.

The *Discovery* is now approaching our shores with this rich harvest of scientific results. Letters have been received from members of the expedition from the Falkland Islands, dated the third week in July. On the whole, good weather had been enjoyed throughout the voyage from New Zealand, and it was anticipated that the *Discovery* would reach England about September 15; but a telegram from Ponta Delgada, which was printed in *The Times* yesterday, indicates that she will arrive much sooner, probably 'about the 10th.' It is seldom in these days that an opportunity is afforded of welcoming home an expedition which has accomplished such brilliant and extensive explorations. Every effort will be made to give all the members of the expedition a fitting reception. On the arrival of the *Discovery* at the London docks it is proposed to entertain officers and men at a luncheon, which it is hoped the Lord Mayor will be able to attend, as well as representatives of the

* From the London *Times*. It is announced by cable that the *Discovery* has duly arrived.

Admirality, the Royal and Royal Geographical Societies and other public bodies. On the following day the Royal Geographical Society will give a dinner to the officers and scientific staff. According to present arrangements, officers and men will then be allowed to rest in peace, so far as public functions of an official character are concerned, until the beginning of November, when it is hoped that Commander Scott will open the new session of the Royal Geographical Society with a summary account of the whole expedition. This will be a special meeting, and possibly will be held in the Albert-hall.

THE CROCKER ECLIPSE EXPEDITION OF THE LICK OBSERVATORY.

Mr. William H. Crocker has offered to meet the expenses of observations on the total solar eclipse of August 30, 1905. Three expeditions will be sent out from the Lick Observatory to Labrador, Spain and Egypt. The provisional program for the three stations is as follows:

Labrador: A photographic search for intramercurial planets in a region of the sky 8½° wide, extending in the direction of the solar equator from 4° below the sun to 15° above it. The photography of the corona by means of a camera of five inches aperture and forty feet focus, of the form first used by Professor Schaeberle at the eclipse of 1893.

Spain: A photographic intramercurial search covering a region 9½° wide, extending in the direction of the solar equator from 14° below to 14° above the sun. The photography of the solar corona with a camera of five inches aperture and forty feet focus. A study of the polarized light in the corona. The use of spectrographs provided with moving plate-holders to obtain a continuous record of changes in the spectrum of the sun's edge at the time of second and third contacts; of spectrographs for determining the wave-length of the green coronal bright line, and, if possible, the wave-lengths of the bright and dark lines in the isolated spectrum of the sun's edge, as nearly as possible at the time when the dark lines give way to bright ones, and *vice versa;* and of a spectrograph for recording the general spectrum of the corona.

Egypt: A photographic intramercurial search 8½°, extending in the direction of the solar equator from 4° below to 15° above the sun. The photography of the solar corona with a camera of five inches aperture and forty feet focus. The photography of the general spectrum of the corona.

SCIENTIFIC NOTES AND NEWS.

Dr. G. K. Gilbert, of the U. S. Geological Survey, has been elected a foreign member of the Accademia dei Lincei, Rome.

Commander R. E. Peary was presented with the gold medal of the French Geographical Society by its president, M. Cordier, at the banquet of the International Geographical Congress given in New York on September 14. In accepting the medal Commander Peary announced his plans for Arctic exploration next year.

Dr. Philipp Lenard, professor of physics at Kiel, and Dr. Adolf de Koenen, professor of geology at Göttingen, have been elected foreign members of the Belgian Academy of Sciences.

Captain R. S. Scott, of the *Discovery,* has been promoted to the rank of a captain in the Royal Navy.

The council of the British Institution of Civil Engineers has, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1903–1904: Telford premiums to Arthur Hill, C.I.E. (Bombay), F. A. Hurley (Cairo), E. M. De Burgh (Greystones), H. H. Dare, M.E. (Sydney, N. S. W.), William Marriott (Melton Constable), T. G. Gribble (London), W. H. Haigh (Cardiff). For students' papers the awards are: A Miller scholarship, tenable for three years, and the James Forrest medal to C. W. L. Alexander, B.E. (Birmingham); Miller prizes to J. M. Clark, M.A., B.Sc. (Glasgow), L. G. Crawford (Barrow-in-Furness), W. H. Dickenson, B.Sc. (Jesmond-on-Tyne), William Lawson (Newcastle-on-Tyne), C. G. Du Cane, B.A. (Middlesbrough), C.

Gribble (York), J. E. Lister (Sheffield), J. M. Kennedy (London), H. Middleton (Newcastle-on-Tyne), J. D. Morgan (Handsworth).

MR. SAMUEL HENSHAW, A.M., of Cambridge, Mass., has been appointed curator of the Museum of Comparative Zoology, at Harvard University. He is the third curator in succession of that museum. Professor Louis Agassiz, the founder, was curator, then director from 1859 until his death; in 1873 he was succeeded by his son, Dr. Alexander Agassiz, who resigned in 1898. Since that date Dr. W. McM. Woodworth has been assistant in charge, then keeper. Mr. Henshaw was connected with the Boston Society of Natural History as assistant from 1876 to 1892, and as secretary and librarian, 1892–1899. He succeeded the late Professor H. A. Hazen as assistant in entomology in the Museum of Comparative Zoology, in 1892 and was appointed librarian in 1899. These two positions he has since held.

THE president of the British Institution of Civil Engineers, Sir William White, and more than one hundred members of the institution, have arrived on the Cunard steamship, *Etruria*, on a visit to the United States and Canada. The invitation to the institution to pay this visit, the first of the kind made since its foundation in 1818, was given by the American and Canadian Societies of Civil Engineers. It is proposed to take part also in the International Engineering Congress organized in connection with the St. Louis Exhibition, to be held in October.

DR. AND MRS. N. L. BRITTON sailed for Nassau, New Providence, on August 19, for the purpose of continuing the exploration of the Bahamas.

MR. MALCOLM PLAYFAIR ANDERSON, of Stanford University, left for Japan early in July to carry on biological work under the auspices of the Zoological Society of London. He will make collections of mammals and birds and other specimens of the island fauna and flora, and a general rough survey of the natural history features.

DR. ERNST A. BESSEY, of the United States Department of Agriculture, who has been abroad for somewhat more than two years, will return about the first of October. While abroad he traveled in Russia, the Caucasus, Turkestan and Algeria, for the Department of Agriculture. He spent some time in study in the Universities of Halle and Munich, finishing his work for the doctorate in Halle last spring.

DURING the past summer Professor C. N. Gould, of the University of Oklahoma, assisted by E. G. Woodruff, conducted investigations on the subject of water supply in the Panhandle of Texas for the United States Geological Survey. Professor Gould last year made a reconnaissance along the Cimarron and South Canadian Rivers in Oklahoma, Texas, Kansas, Colorado and New Mexico, and on the completion of the field studies submitted a report on the geology and water resources of Oklahoma. A similar report on the water resources of the Panhandle will be submitted during the coming winter.

DR. W. A. MURRILL has been appointed assistant curator, at the New York Botanical Garden, in the place of Professor F. S. Earle, who resigned to become director of the Experiment Station of Cuba.

MR. R. M. ARANGO has been appointed a consulting engineer on the staff of Chief Engineer Wallace in the Panama Canal construction.

DR. ALEXANDER C. ABBOTT, chief of the Bureau of Health, and professor of hygiene in the University of Pennsylvania, delivered the inaugural address at McGill University, on September 12.

DR. J. DENIKER, librarian of the Paris Museum of Natural History, will deliver the Fifth Huxley Memorial Lecture of the Anthropological Institute of Great Britain and Ireland, on October 7. He will take as his subject 'The Races of Europe.'

DR. C. L. HERRICK, editor of the *Journal of Comparative Neurology and Psychology*, died at Socorro, New Mexico, on September 15. Stricken with pulmonary tuberculosis early in 1894, he left his professorship in Denison University and succeeded for more than ten years in holding his disease in check in the climate of the far south-west. This period of

exile, though filled with suffering and privation, was one of the most productive of his life. During four of these years as president of the Territorial University of New Mexico he did valiant service for the cause of higher education in the southwest, and during the whole time was conducting and publishing researches in zoology and geology, besides supporting his family by practising as a mining expert. During the last few months of his life failing physical strength gave opportunity for a final formulation of much unfinished work, particularly in philosophical lines, a part of which has already been published, and much of which is still in manuscript.

Professor Ed. von Martens, vice-director of the Berlin Zoological Museum, died on August 14, at the age of seventy-three years.

We also regret to record the death of Dr. P. van der Vliet, formerly professor of physics at the University of St. Petersburg, aged sixty-four years.

King Edward has directed that a new medal be struck for service in polar regions. The officers and crew of the Antarctic exploration ship *Discovery* will be the first recipients of the medal.

The U. S. Civil Service Commission will hold an examination on October 12, for the position of assistant to the agrostologist, of the Bureau of Plant Industry, Department of Agriculture, with a salary of $1,400 a year. On the same day an examination will be held for the position of assistant preparator in the Division of Vertebrate Paleontology, National Museum, at a salary of $480 a year.

In a recent number of the *Bulletin* of Lick Observatory, Professor W. W. Campbell states that the late Director Keeler's observing program for the Crossley reflector included the photography of about one hundred of the principal nebulæ and star clusters. The portions of this program available for observation in clear summer weather were practically complete at the time of his death; but those in position during the cloudy winter months, forming nearly a half of the whole, were incomplete. After the lamented death of Professor Keeler, Assistant Astronomer Perrine, in charge of the Crossley reflector, made it his first duty to complete the observing program. This was accomplished in September, 1903. The importance of prompt publication of this invaluable series of photographs has been fully realized, but difficulties, both technical and financial, have existed. Owing to the generosity of friends of the Lick Observatory plans have recently been completed, whereby it is hoped to issue, within the coming half-year, a volume of the *Lick Observatory Publications*, to contain high-class reproductions of seventy-two of the principal subjects, as well as a list of several hundred new nebulæ incidentally recorded on the negatives.

The University of Chicago paleontological expedition to Wyoming the past summer has obtained a valuable and extensive collection of land reptiles from the Trias. The material collected includes labyrinthodonts, dinosaurs, anomodonts and phytosaurs of several kinds. One specimen, largely complete, apparently belonging in the last group, has a slender, teleosaur-like skull nearly three feet in length, armed with serrated, cutting, dinosaur-like teeth. Several labyrinthodont skulls of at least two forms were obtained. The material will be described as soon as possible by Dr. S. W. Williston and Mr. E. B. Branson, of the University of Chicago.

The International Geographic Congress and the Society of Chemical Industry have been holding their meetings and making the visits in accordance with the programs to which we have already called attention. We hope to publish later some account of the proceedings.

The International Astronomical Congress began its meetings at Lund on September 5.

The second International Congress of Philosophy was opened at the university at Geneva on September 4, with 316 members in attendance.

The fifteenth annual general meeting of the British Institution of Mining Engineers was held at Birmingham on September 14.

The fourth Congress of the International Aeronauts' Committee, with about 60 members in attendance, met at St. Petersburg, beginning on August 30.

THE International Conference for Wireless Telegraphy, summoned at the initiative of Germany, which was to have met October 4, has been postponed at the request of France and Great Britain, these countries desiring more time to study the questions involved.

A REUTER telegram from Basel, dated August 30, states: "The second International Congress on the History of Religions was opened at 11 o'clock this morning. Professor von Orelli, of Basel, president of the organizing committee, in opening the first plenary sitting, welcomed the delegates, and speeches were also made by Professor Raville, representing the Swiss Federal Council, and Professor Burckhardt, representing the Cantonal government, and by members of various learned societies. The speakers included Dr. Hauptmann, of Baltimore, on behalf of the United States government, and Mr. H. M. A. Balfour, on behalf of Oxford University. Professor von Orelli then read an address in the course of which he pointed out that the objects of the conference were purely scientific, and that a propaganda in favor of a particular sect and controversies on the lines of religious discussions during the middle ages would not be allowed. Over 300 savants from all parts of the world have already arrived. The conference will be divided into eight sections, seven of which will deal with the religions of the following peoples and countries respectively: (1) Primitive Races, including the Peruvians and Mexicans; (2) the Chinese and Japanese; (3) the Egyptians; (4) the Jews; (5) India and Persia; (6) the Greeks and Romans; and (7) the Germanic, Celtic, Slavonic and Hungarian Races. The eighth section will devote itself to the discussion of the Christian Religion."

WE learn from *Nature* that it is proposed to fix a standard time for use upon all Indian railways and telegraphs, which shall be exactly five and one half hours in advance of Greenwich time, and to fix for Burma a standard six and one half hours in advance of Greenwich. The government of India has intimated that it is in favor of the adoption of the new standard for general as well as for railway and telegraphic purposes, and is prepared to cooperate in any movement with this end in view; but as the matter is one upon which the local communities should be consulted, the opinions of the chambers of commerce upon the proposals are being sought by the government.

WE learn through the London *Times* that the annual report for 1903 of the Swiss National Museum at Zürich, recently published, contains an account of a donation to that institution by Dr. H. Angst, C.M.G., the founder, for all practical purposes, of the museum, and its first director. At the end of last year, Dr. Angst resigned the directorship, but accepted a position as representative of the Canton of Zürich on the museum commission. Before his retirement, however, had actually taken place, but when it had been already decided on, Dr. Angst crowned his life's work for the museum by presenting to the institution at once, substantially the whole of his great and almost unique collection of Swiss antiquities, including glass and pottery. Even before the museum was opened, Dr. Angst had made over to it a very valuable collection, representing some £4,000 sterling; and soon after, fearing that in a private house they might be exposed to danger, he entrusted to the institution as a loan the rest of his collection, embracing antiquities of all sorts, in the purchase of which not less than £20,000 had been actually expended, while with the rise in market prices, the present value is much greater. This property Dr. Angst has now conveyed, in immediate and complete possession, to the museum without waiting for his death, one half of it—that is £10,000 value—as an unconditional gift, and the other half in consideration of a payment in cash of £2,000 and of a moderate life-rent to cover the balance. This act was gratefully recognized by the Swiss government in an official letter signed by the president and the chancellor of the Confederation, and by the rising of the members of the National Council in their seats when the donation was publicly announced.

THE new metallurgical smelting-house at Bournbrook in connection with Birmingham University was formally opened on Sep-

tember 5. In an introductory lecture at the university Professor Turner said, according to the London *Times*, that the beginning of the work marked an important event in the history of the section. The erection of the building had occupied a year and entailed an expenditure of not much less than £10,000. There was no more ready index of the progress of civilization in any nation than that afforded by the knowledge of the work and value of its metallurgical products, and it was of the utmost importance that metallurgical industries should be encouraged and developed if Great Britain were to keep her position amongst the nations of the world. With regard to the position of the United Kingdom in metallurgical industries, a great change had been witnessed in the last twenty-five years. England used to be spoken of as the chief coal and iron producer of the world, and also occupied a prominent position as a producer of other metals. It still led in gold because of the Transvaal and Australia, but was now second in coal, third in iron, fifth or sixth in other metals, and only produced about one twentieth part of the tin, lead and zinc which were made in the world. The two chief competitors had been the United States and Germany, and the reasons for their progress were varied. In America there were the necessities of a new country, the rapid development of their railways, the opening up of enormous fields of ore deposits and coal fields. There was also the question on which the chancellor of the university had spoken a great deal, the question of tariffs; but he was more immediately interested at the present moment in the influence of education on metallurgical progress and the lines that should be followed in connection with that subject. Professor Turner went on to enumerate the schools of metallurgy in America and Germany, and to show that some of them were on a scale that had hitherto not been matched in Great Britain.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Dr. Henry Tuck, Harvard University will receive one fourth of the estate should his children not survive. The estate is valued at $5,000,000.

Ground was broken for the new Eastman building of Rochester University, to be used for biology and physics, for which Mr. Eastman, of Rochester, gave $60,000. The effort to raise necessary funds towards the $150,000 required for the building has been successful. Of the desired amount, the sum of $120,000 is in hand, including $15,000 contributed by Hiram W. Sibley for the renovation and decoration of the library.

The following assistants have been appointed at Leland Stanford Junior University: *Mechanical Engineering*, R. H. Gaither; *Education*, E. R. Snyder, Miss C. F. Atherton; *Entomology*, Miss M. I. McCracken; *Zoology*, W. K. Fisher, H. M. Spaulding; *Physics*, C. K. Studley, Miss G. N. Brown; *Physiology*, J. F. Cowan, M. Sindo; *Chemistry*, W. E. Crawford, C. C. James, N. E. Dole, R. H. Sherry, Miss J. A. Comings, D. F. Fitzgerald, W. E. Burke; *Civil Engineering*, J. F. Byxbee, T. B. Hunter, Jr., E. G. Brua, L. J. Mayreis, G. A. Hodge.

C. G. Rogers, assistant in physiology in the University of California, has been appointed instructor in physiology at the University of Kansas.

Mr. Alexander Lauder, senior demonstrator in chemistry in the University College of North Wales, Bangor, has been appointed lecturer in agricultural chemistry in the Edinburgh and East Scotland College of Agriculture.

Dr. Oskar Hertwig, professor of comparative anatomy, at Berlin, has been appointed rector of the University.

Professor E. Wichert, of Göttingen, has been called to a chair of physics at Königsberg; Professor Eduard Brückner, of Bern, has been called to a professorship of geography, at Halle.

Professor O. E. Meyer, director of the Physical Laboratory, at Breslau, will retire from active service at the close of the present semester.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 30, 1904.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE UNITY OF PHYSICAL SCIENCE.*

THERE is a tradition, still tacitly sanctioned even by men of science, that there have been epochs when the more eminent minds were able to compass the entire range of knowledge. Amongst the vanishing heroic figures of the past it seems possible, indeed, to discern, here and there, a Galileo, a Huygens, a Descartes, a Leibnitz, a Newton, a Laplace or a Humbolt, each capable, at least, of summing up with great completeness the state of contemporary knowledge. Traditions, however, are generally more or less mythical, and the myth in this case seems to be in flat contradiction with the fact that there never was such an epoch, that the great masters of our distinguished predecessors were, after all, much like the masters of to-day, simply the leading specialists of their times. But however this may be, if we grant the possibility of the requisite attainments, even in a few individuals at any epoch, we shall speedily conclude that there never was an epoch so much in need of them as the immediate present, when the divisional speakers of this congress are called upon to explain the unities which pervade the ever-widening and largely diverse fields of their several domains.

The domain of physical science, concerning which I have the honor to address you to-day, presents peculiar and peculiarly formidable difficulties in the way of a summary review. While we may not be dis-

* Address before the Division of Physical Science, International Congress of Arts and Science, St. Louis, September 19–25, 1904.

posed to limit the wide range of inclusion specified by our program, we must at once disclaim any attempt to speak authoritatively with respect to most of its details. There is, in fact, such a vast array of knowledge now comprehended under any one of the six departments of our division, that the boldest author must hesitate to enter on a limited discussion with respect to any of them. But if it is thus difficult to consider any department of physical science, it appears incomparably more difficult to contemplate all of them in the bewildering complexity of their interrelations and in the bewildering diversity of their subject-matter. What, for example, could seem more appalling to the average man of science than the duty of explaining the connections of archeology and astrophysics or those of ecology and electrons?

Happily, however, the managers of the congress have provided an adequate division of labor, whereby the technical details of the various departments are allotted to experts, giving thus to a divisional speaker a degree of freedom with respect to depth in some way commensurate with the breadth of his task. Presuming, therefore, that I may deal only with the broader outlines and salient features of the subject, I invite your attention to a summary view of the present status and the apparent trend of physical science.

Whatever may be affirmed with respect to science in general, there appears to be no doubt that all of the physical sciences are characterized by three remarkable unities —a unity of origin, a unity of growth and a unity of purpose. Physical science originates in observation and experiment; it rises from the fact-gathering stage of unrelated qualities to the higher plane of related quantities, and passes thence on to the realm of correlation, computation and prediction under theory; and its purpose is to interpret in consistent and verifiable terms the universe, of which we form a part. The recognition of these unities is of prime importance; for it helps us to understand and to anticipate a great diversity of perfection amongst the different branches of science, and hence leads us to appreciate the desirability of hearty cooperation on the part of scientific workers in order that progress may be ever positive towards the common goal.

Glancing rapidly seriatim at the different departments of physical science as specified by our program, we come first to a consideration of formal physics, and we may most quickly orient ourselves aright in this department by trying to state in what respects the physics of to-day differs from the physics of a hundred years ago.

In spite of the extraordinary perfection of the work of Lagrange, Laplace, Fourier, Young, Fresnel, Poisson, Green, Gauss and others of the early part of the nineteenth century, it will be at once admitted that great progress has been made. In addition to noteworthy advances and improvements along the lines laid down by these masters, there have been developed the relatively new fields of elasticity, electromagnetics, thermodynamics and astrophysics; and there has been discovered the widest of all generalizations in physical science—the law of conservation of energy. Whereas it was easy a century ago to conceive, as in gravitational astronomy, of action at a distance across empty space, the universe in the meantime has come to appear more and more plethoric not only with 'gross matter,' but with that most wonderful entity we call the ether. The astronomers have shown us, in fact, that the number of molar systems in the universe is enormously greater than was supposed possible a century ago; while the physicists have revealed to us molecular systems rivaling our solar system and its Jovian and Saturnian subsystems, and they have loaded down the ether

with a burden of properties and relationships which its usual tenuity seems scarcely fitted to bear. Whereas, also, a century ago the tendency of thought, under the stimulus of the remarkable developments of the elastic solid theory of light and the fluid theories of electricity, was chiefly towards an ether whose continuity would have pleased Anaxagoras, the tendency to-day is chiefly towards an ether whose atomicity would have pleased Democritus.

On the whole, it must be said that the advances of the past century, and especially those of the past half century, have been mainly along the lines of molecular physics. The epoch of Laplace was distinctly an epoch of molar physics; the epoch of to-day is distinctly an epoch of molecular physics. Light, heat, electricity and magnetism have been definitely correlated as molecular and ethereal phenomena; while the recently discovered X-rays and the wonders of radioactivity, along with the 'electrons,' the 'corpuscles' and the 'electrions' of current investigations, all point towards a molecular constitution of the ether. Thermodynamics, likewise, large as it has grown in recent decades, is essentially a development of the molecular theory of gases. It would be too bold, perhaps, to assert that the trend of accumulating knowledge is towards an atomic unity of matter, but the day seems not far distant when there will be room for 'a new Principia' and for a treatise which will accomplish for molecular systems what the 'Mécanique Céleste' accomplished for the solar system.

One of the most important advances of recent decades is found in the fixation of ideas with respect to the units of physical science and in the great improvements which have been wrought in metrology by the 'International Bureau of Weights and Measures.' Our standards of length, mass and time are now fixed with a degree of precision which leaves little to be desired for the present, and the capital resources of measurement and calculation are now available to an extent never hitherto approached.

It should be noted, however, that confidence in the stability of our standards is by no means comparable with the perfection of their current applications. Indeed, we may raise with respect to them the question so long mooted with regard to the motions of the members of the solar system, namely, are they stable? Notwithstanding the admirable precision of the intercomparisons of the prototype meters and prototype kilograms and the equally admirable precision of Professor Michelson's determination of the length of the meter in terms of wave lengths of cadmium light, we can not affirm that these observed relations will hold indefinitely. Our inherited notions of mass have been rather rudely shaken, also, by the penetrating criticisms of Mach, and it appears possible even that the law of conservation of mass may need modification in the light of pending researches. But worst of all, our time unit, the sidereal day, is so far from possessing the element of constancy that we may affirm with practical certainty that it is secularly variable. Having realized, through Professor Michelson's superb determination just referred to, the cosmic standard of length suggested by Maxwell thirty years ago, we are now much more in need of an equally trustworthy cosmic standard of time.

If the progress of physics during the past century has been chiefly in the direction of atomic theory, the progress of chemistry has been still more so. Chemistry is, in fact, the science of atoms and molecules par excellence, a distinction it has maintained for well nigh a full century under the dominance of the fruitful atomic and molecular hypotheses of Dalton and of

Avogadro and Ampère, and under the similarly fruitful laws of gases established by Dalton and Gay-Lussac. Perhaps the most striking feature of this progress, in a general way, is the gradual disappearance it has entailed of the imaginary lines which have been long thought to separate the fields of chemistry and physics. Through the remarkable discoveries of Faraday the two fields have been found to overlap in actual electrical contact. Through the wonderful revelations of spectrum analysis, originating with Bunsen and Kirchhoff, they have been proved to be very largely common ground. And through the broader generalizations inaugurated by Willard Gibbs, Helmholtz and others, they are now both somewhat in danger of being annexed as a subprovince of rational mechanics.

To one whose work has fallen more especially in the fields of precise astronomy, geodesy or metrology, it might seem a just reproach to chemistry that it is a science whose measurements and calculations demand, as a rule, no greater arithmetical resources than those of four-place tables of logarithms and anti-logarithms. The so-called 'Constants of Nature' supplied by chemistry are, in fact, known with a low degree of certainty, a degree expressed, say, by three to five significant figures. A small amount of reflection, however, will convince one that the phenomena with which the chemist has to deal are usually far more complex than those which have yielded the splendid precision of astronomy, geodesy and metrology. Moreover, it should be observed that the certainties even of these highly perfected sciences are very unequal in their different branches. It appears more correct, therefore, as well as more just, considering the central position it occupies and the wide range of its ramifications, along with the vast aggregate of qualitative and quantitative knowledge it has massed, to assert that the precision of chemistry affords the best numerical index of the present state of physical science. That is, when reduced to the most compact form of statement, the certainties of physical science are best indicated, in a general way, by a table of the combining weights of the eighty-odd chemical elements.

When one contemplates the numbers of such a table, and when one adds to its suggestions those which flow from the various periodic groupings of the same numbers, he can hardly avoid being inspired by the day dreams of those who have looked long for the atomic unity of matter. But however the grand problem which thus obtrudes itself may be resolved finally, it appears certain that this table must stand as one of the great landmarks along the path of progress in physical science.

It was justly remarked by Laplace in his 'Système du Monde' that 'L'Astronomie, par la dignité de son objet et par la perfection de ses théories, est le plus beau monument de l'esprit humain, le titre le plus noble de son intelligence'; and we must all admit that subsequent progress has gone far to maintain this high position for the most ancient and interesting of the older sciences. One finds little difficulty in accounting for the early rise of astronomical science and for the universal interest in celestial phenomena. Their immanence and omnipresence appeal even to the dullest intellects. But it is not so easy to account for the remarkable fact that although astronomy deals chiefly with the relations of bodies separated by immense distances, progress in its development has thus far been at least equal to, if not in advance of, the progress of physics and chemistry, which have to deal with matter close at hand. Without attempting a full explanation of this fact, it may suffice to observe that the principal phenomena of astronomy thus far developed appear to be relatively simple in comparison with those of the

other physical sciences; and that the immense distances which separate the celestial bodies, instead of being an obstacle to, are a fortunate circumstance directly in favor of, the triumphant advances which have distinguished astronomical science from the epoch of Galileo down to the present day.

Not less noteworthy than his high estimate of the position of astronomy in his time are Laplace's anticipations of the course of future progress. Our admiration is kindled by the clearness of his vision with respect to ways and means and by the penetration of his predictions of future discoveries. Advances in sidereal astronomy, he rightly thought, would depend chiefly on improvements in telescopes; while advances in dynamical astronomy were to come along with increased precision in the observed places of the members of the solar system and along with the growing perfection of analysis. It is almost needless to say that Laplace's brilliant anticipations have been quite surpassed by the actual developments. Observational astronomy has become one of the most delicately perfect of all the sciences; dynamical astronomy easily outstrips all competitors in the perfection of its theories and in the certainty of its predictions; while the newly developed branch of astrophysics supplies the last link in the chain of evidence of the essential unity of the material universe.

The order of the dimensions and the order of the mass contents of the visible universe, at any rate, have been pretty clearly made out. In addition to the vast aggregate of direct observational evidence collected and recorded during the past century, numerous theoretical researches have gone far, also, to interpret the laws which reign in the apparent chaos of the stars. The solar system, with its magnificent subsystems, has been proved to exhibit the type of stellar systems in general.

In a profound investigation recently published, Lord Kelvin has sought to correlate under the law of gravitation the principal observed data of the visible universe. Assuming this universe to lie within a sphere of radius equal to the distance of a star whose parallax is one thousandth of a second of arc, he concludes that there must be something like a thousand million masses of the magnitude of our sun within that sphere. Light traveling at the rate of 300,000 kilometers per second would require about six thousand years to traverse the diameter of this universe, and while the average distance asunder of the visible stars is considerably less, it is still of the same order. It is only essential, therefore, to imagine our luminary surrounded by a thousand million such suns, most of which are, in all probability, attended by groups of planets, to get some idea of the quantity of matter within visual range of our relatively insignificant terrestrial abode. And the imposing range of the astronomer's time scale is perhaps impressively brought home to us when we reflect that a million years is the smallest convenient unit for recording the life history of a star, while the current events in that history are transmitted across the interstellar medium by vibrations which occur at the rate of about six hundred million million times per second. Measured by its accumulation of achievements, then, the astronomy of to-day fulfils the requirements of a highly developed science. It is characterized by a vast aggregate of accurately determined facts related by theories founded on a small number of hypotheses. In the past it has called forth the two greatest of all systematic treatises, the 'Principia' of Newton and the 'Mécanique Céleste' of Laplace. It has probably done more also than any other science, up to the present time, to illuminate the dark periods during which man has floundered in his struggle for

advancement; and the indications are that its prestige will long continue.

But there are spots on every sun; and lest some may infer, even humorously, as Carlyle did seventy-odd years ago, that our system of the world is 'as good as perfect,' attention should be called to some noteworthy defects in astronomical data and to some singular obscurities in astronomical theory. Here, however, great caution and brevity are essential to avoid poaching on the preserves of our colleagues of the sections. It may suffice, therefore, to merely mention, under the head of defective data, the low precision of the solar parallax, the aberration constant, the masses of the members of the solar system, and the uncertainty of our time unit, already referred to. Two instances, likewise, which belong to the general field of physics as well, may suffice as illustrations of obscurities in astronomical theory. Stated in the order of their apparent complexity, these obscurities refer to the law of gravitation and to the phenomenon of stellar aberration. Probably both are related, and one may hope that any explanation of either will throw light on the other.

So long as no attempt is made to reconcile the law of gravitation with other branches of physics, progress, up to a certain point, is easy; and probably great advantage has resulted from the fact that dynamical astronomers have not been seriously disturbed by a desire to harmonize this law with the more elementary laws of mechanics. Perhaps they have unconsciously rested on the platform that gravitation is one of the 'primordial causes' which are impenetrable to us. There are some indications that even Laplace and Fourier did so rest. But, however this may be, it has grown steadily more and more imperative during the past century to explain gravitation, or to discover the mechanism which provides that the force between two widely separated masses is proportional to their product directly and to the square of the distance between them inversely. All evidence seems to indicate that the ether must provide this mechanism; but, strangely enough, so far, the ether has baffled all attempts to reveal the secret. The problem has been attacked also on the purely observational side of the numerical value of the gravitation constant. But the splendid experimental researches for this purpose throw no light on the mechanism in question, and, unfortunately, they bring out values for the constant of a low order of precision.

With regard to stellar aberration, it must be at once admitted that we have neither an adequate theory nor a precisely determined fact. The astronomer has generally contented himself with the elementary view that aberration is a purely kinematical phenomenon; that the earth not only slips through the ether without sensible retardation, but that the ether slips through the earth without sensible effects. This difficulty was recognized, in a way, by Young and Fresnel, and, although the subject of elaborate investigation in recent decades, it has proved equally baffling with Newtonian gravitation. As in the case of the latter also, the numerous attempts made to determine the constant of aberration by observational methods have been rewarded by results of only meager precision. Possibly the time has arrived when one may raise the question, Within what limits is it proper to speak of a gravitation constant or of an aberration constant?

If we agree with Laplace that astronomy is entitled to the highest rank among the physical sciences, we can accord nothing short of second place to the sciences of the earth. Most of them are, indeed, intimately related to astronomy; and some of them are scarcely less ancient in their origins, less dignified in their objects, or

less perfect in their theories. Primarily, also, it should be observed, geophysics is not simply a part of, but is the very foundation of, astronomy; for the earth furnishes the orientation, the base-line, and the timepiece by means of which the astronomer explores the heavens. Geology, likewise, in the broader sense of the term, as we are now coming to see, is a fundamental science not only by reason of its interpretations of terrestrial phenomena, but also by reason of its parallel interpretations of celestial phenomena; for there is little doubt that in the evolution of the earth we may read a history which is in large degree typical of the history of celestial bodies. In any revised estimate, therefore, of the relative rank of the physical sciences, while it would be impossible to lower the science of the heavens, it would appear essential to raise the sciences of the earth to a much higher plane of importance than was thought appropriate by our predecessors of a hundred years ago.

As with physics, chemistry and astronomy, the wonderful progress of the nineteenth century in geophysical science has been along lines converging towards the more recondite properties of matter. All parts of the earth, through observation, experiment, induction and deduction, have yielded increasing evidence of limited unities amid endless diversities. Adopting the convenient terminology of geologists for the different shells of the earth, let us glance rapidly in turn at the sciences of the atmosphere, the hydrosphere or oceans, the lithosphere or crust, and the centrosphere or nucleus.

The atmosphere is the special province of meteorologists, and although they are not yet able to issue long-range predictions, like those guaranteed by our theories of tides and terrestrial magnetism, it must be admitted that they have made great progress towards a rational description of the apparently erratic phenomena of the weather. One of the peculiar anomalies of this science illustrates in a striking way the general need of additional knowledge of the properties of matter; in this case, especially, the properties of gases. It is the fact that in meteorology greater progress has been made, up to date, in the interpretation of the kinetic than in the interpretation of the static phenomena of the atmosphere. Considering that static properties are usually much simpler than kinetic properties, it seems strange that we should know much more about cyclones, for example, than we do about the mass and the mass distribution of the atmosphere. In respect to this apparently simple question meteorology seems to have made no advance beyond the work of Laplace. There are indications, however, that this, along with many other questions, must await the advent of 'a new Principia.'

The geodesists, who are the closest allies of the astronomers, may be said to preside over the hydrosphere, since most of their theories as well as most of their observations are referred to the sea level. They have determined the shape and the size of the earth to a surprising degree of certainty; but they are now confronted by problems which depend chiefly on the mass and mass distribution of the earth. The exquisite refinement of their observational methods has brought to light a minute wandering in the earth of its axis of rotation, which makes the latitude of any place a variable quantity; but the interpretation of this phenomenon is again a physical and not a mensurational problem. They have worked improvements also in all kinds of apparatus for refined measurements, as of base-lines, angles and differences of level; but here, likewise, they appear to approach limits set by the properties of matter.

The lithosphere was once thought to be

the restricted province of geologists, but they now lay claim to the entire earth, from the center of the centrosphere to the limits of the atmosphere, and they threaten to invade the region of the astronomers on their way towards the outlying domain of cosmogony. Geology illustrates better than any other science, probably, the wide ramifications and the close interrelations of physical phenomena. There is scarcely a process, a product or a principle in the whole range of physical science, from physics and chemistry up to astronomy and astrophysics, which is not fully illustrated in its uniqueness or in its diversity by actual operations still in progress on the earth, or by actual records preserved in her crust. The earth is thus at once the grandest of laboratories and the grandest of museums available to man.

Any summary statement, from a non-professional student, of the advances in geology during the past century, would be hopelessly inadequate. Such a task could be fitly undertaken only by an expert, or by a corps of them. But out of the impressive array of achievements of this science, two seem to be specially worthy of general attention. They are the essential determination of the properties and the rôle of the lithosphere, and the essential determination of the time scale suitable for measuring the historical succession of terrestrial events. The lithosphere is the theatre of the principal activities, mechanical and biological, of our planet; and a million years is the smallest convenient unit for recording the march of those activities. When one considers the intellectual as well as the physical obstacles which had to be surmounted, and when one recalls the bitter controversies between the Neptunists and the Vulcanists and between the Catastrophists and the Uniformitarians, these achievements are seen to be amongst the most important in the annals of science.

The centrosphere is the *terra incognita* whose boundaries only are accessible to physical science. It is that part of the earth concerning which astronomers, geologists and physicists have written much, but concerning which, alas! we are still in doubt. Where direct observation is unattainable, speculation is generally easy, but the exclusion of inappropriate hypotheses is, in such cases, generally difficult. Nevertheless, it may be affirmed that the range of possibilities for the state of the centrosphere has been sharply restricted during the past half century. Whatever may have been the origin of our planet, whether it has evolved from nebular condensation or from meteoric accretion; and whatever may be the distribution of temperature within the earth's mass as a whole; it appears certain that pressure is the dominant factor within the nucleus. Pressure from above, supplied in hydrostatic measure by the plastic lithosphere, supplemented by internal pressure below, must determine, it would seem, within narrow limits the actual distribution of density throughout the centrosphere, regardless of its material composition, of its effective rigidity or of its potential liquidity. Here, however, we are extending the known properties of matter quite beyond the bounds of experience, or of present possible experiment; and we are again reminded of the unity of our needs by the diversity of our difficulties.

In his recently published autobiography, Herbert Spencer asserts that at the time of issue of his work on biology (1864) 'not one person in ten or more knew the meaning of the word * * *; and among those who knew it, few cared to know anything about the subject.' That the attitude of the educated public towards biological science could have been thus indifferent, if

not inimical, forty years ago, seems strange enough now even to those of us who have witnessed in part the scientific progress subsequent to that epoch. But this was a memorable epoch, marked by the advent of the great intellectual awakening ushered in by the generalizations of Darwin, Wallace, Spencer and their coadjutors. And the quarter of a century which immediately followed this epoch appears, as we look back upon it, like an heroic age of scientific achievement. It was an age during which some men of science, and more men not of science, lost their heads temporarily, if not permanently; but it was also an age during which most men of science, and thinking people in general, moved forward at a rate quite without precedent in the history of human advancement. A new, and a greatly enlarged, view of the universe was introduced in the doctrine of evolution, advanced and opposed alike, vigorously, chiefly by reason of its biological applications and implications. Galileo, Newton and Laplace had given us a system of the inorganic world; Darwin, Spencer and their followers have foreshadowed a system which includes the organic world as well.

The astonishing progress of biology in recent times furnishes the most convincing evidence of the unity and the efficiency of the methods of physical science in the interpretation of natural phenomena. For the biologist has followed the same methods, with changes appropriate to his subject-matter, only, as those found fruitful in astronomy, chemistry and all the rest. And whatever may be the increased complexity of the organic over the inorganic world, or however high the factor of life may seem to raise the problems of biology above the plane of the other physical sciences, there has appeared no sufficient reason, as yet, to doubt either the validity or the adequacy of those methods.

Moreover, the interrelations of biology with chemistry and physics especially, are yearly growing more and more extended and intimate through the rapidly expanding researches of bacteriology, physiology and physiological chemistry, plant and animal pathology, and so on, up through cytology to the embryology of the higher forms of life. Through the problems of these researches also we are again brought face to face, sooner or later, with the problems of molecular science.

And finally, what may be said of anthropology, which is at once the most interesting and the most novel of the physical sciences, interesting by reason of its subject matter, novel by reason of its applications? Some of us, perhaps, might be inclined to demur from a classification which makes man, along with matter, a fit object of investigation in physical science. Granted even that he is usually a not altogether efficient thermodynamic engine, it may yet appear that he is worthy of a separate category. Fortunately, however, it is not a rule of physical science to demand immediate answers to such ulterior questions. It is enough for the present to know that man furnishes no exception, save in point of complexity, to the manifestations of physical phenomena so widely exhibited in the animal kingdom.

But whatever may be our inherited prejudices, or our philosophic judgments, we are confronted by the fact that the study of man in all his attributes is now an established domain of science. And herein we rise to a table-land of transcendent fascination; for, to adapt a phrase of an eminent master in physical science, the instruments of investigation are the objects of research. Herein also we find the culminating unity, not only of the physical sciences, but of all of the sciences; and it is chiefly for the promotion of these higher interests of anthropology that we are as-

sembled in this cosmopolitan congress today.

It has been our good fortune to witness in recent decades an unparalleled series of achievements in the fields of physical science. All of them, from anthropology and astronomy up to zoology, have yielded rich harvests of results; and one is prone to raise the question whether a like degree of progress may be expected to prevail during the century on which we have now entered. No man can tell what a day may bring forth; much less may one forecast the progress of a decade or a century. But, judging from the long experience of the past, there are few reasons to doubt and many reasons to expect that the future has still greater achievements available. It would appear that we have found the right methods of investigation. Philosophically considered, the remarkable advances of the past afford little cause for marvel. On the contrary, they are just such results as we should anticipate from persistent pursuit of scientific investigation. Conscious of the adequacy of his methods, therefore, the devotee to physical science has every inducement to continue his labors with unflagging zeal and confident optimism.

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*MICRO-ORGANISMS OF SOIL AND HUMAN WELFARE.**

Man has gained dominion in the earth not as a birthright, but by many struggles and by numerous conquests. Slowly during the ages he has gained accessions of knowledge and has succeeded in making more and more use of the forces of nature. The introduction of the art of printing enabled him to make readily and to keep permanently a record of his accomplishments; the discovery of the mariner's compass added immensely to his domain; the application of steam multipled a thousand times his power, and now the subjection of the electric forces makes him a veritable master over time and space. As a help in gaining knowledge applicable to the practical affairs of earth and life the microscope stands unrivaled. Its relations have been incomparably important in regard to the knowledge of man himself and to those things immediately connected with his daily existence and health. Bacteriology is a branch of microscopy or at all events could not have been developed without the aid of the microscope, and in this connection alone the instrument has been useful beyond any other piece of mechanism whatever in alleviating ills to which flesh is heir and in promoting and prolonging life.

So far bacteria have been more especially studied as disease germs. Witness the advance which has been made on account of those studies in medicine and surgery, in the efficiency of quarantines and in the prevention of epidemics. It is argued now in some quarters that even old age is a germ disease, and that immortality on earth is a possibility when bacteriology and its allied sciences come to perfection. I am to ask your attention at this time to some of the microorganisms of the soil and their relation to soil fertility. This is a technical subject. While it is not possible to treat it as a popular theme, it should not be difficult to show that there are matters here which, whether we are aware of it or not, intimately and immeasurably affect every human being on earth.

First a few words as to the organisms themselves. They are minute living creatures belonging to the vegetable kingdom, hence called plants, however unlike they are to the leafy structures usually alluded to by that name. Their most striking peculiarities are their exceedingly diminutive

* Presidential address read at the Buffalo meeting, August 24, 1904, of the American Microscopical Society.

size, and their possibilities of reproduction. In the terms of the microscopist a half micron is about the diameter of the smaller kinds and twice this for the larger ones. That is, from .0005 to .001 mm., or .00002 to .00004 inch. It requires 13 sheets of the typewriting paper on which this is written to measure in thickness one mm., therefore there is room across the cut edge of one sheet for about 77 of the larger or 144 of the smaller of these bacteria to lie side by side. Of course a single organism is absolutely invisible to the naked eye and can not be seen without more than 100 times magnification. To study bacteria effectively the best compound microscope is often taxed to its utmost limits.

Over and against the diminutive size may be placed the extraordinary powers of multiplication of these minute creatures. In the case of many common species any one of the organisms may become two by a simple process of self-division within thirty minutes of time, when conditions are favorable. At this rate at similar intervals of a half hour each, two become four, four become eight, eight become sixteen, etc. This continued for 48 half-hours, one day and night, makes the enormous number of 281,470,000,000 individuals. This seems incredible, but a little calculation which can be made by any schoolboy will prove the statement. As shown by the census of 1900, there were then in Illinois 4,881,450 people. The number of bacteria produced in 24 hours from a single organism is, according to this, 58,327 times as many as the human population of Illinois, and is equal to something like 185 times the number of people in the whole world.

We are not to take from this that such a rate of multiplication ever actually continues for any very considerable time, for, small as these single organisms are, there would soon be room for nothing else on the earth. This rate of growth and self-division only occurs while all the conditions are favorable. Now, even if other things so continued, the prodigiously increasing numbers themselves would soon interfere with further advance. There are limitations here as there are to the number of people in a house. Even if nothing else prevents, their own excretions or other products may arrest growth. For instance, the souring of milk is for the most part caused by a particular species of bacteria. The individual organisms belonging to this species increase very rapidly in fresh milk at the proper temperature, and lactic acid is produced. But the proportion of this acid does not rise above eight tenths of one per cent., for this amount becomes prohibitive of further activity on the part of the organism. Its numbers do not further increase unless the acid is more or less neutralized by some alkaline substance. From some such cause our phenomenal numbers are not often found as the product of one bacterium in 24 hours, but the calculations do show approximate facts and do help us to explain observed results. One bacterium, perhaps one thirty-thousandth of an inch in diameter, far too small to be seen by the unaided eye, can do comparatively nothing while several thousands of them in a drop of broth may soon cause its putrefaction.

So much has been said of bacteria as germs of virulent diseases, as agents of pollution, as destroyers generally that we may well think of them as invisible enemies with which we must ever battle to live, or to have anything to live upon. To-day we are to discuss some of the benefits they confer upon us, and we shall see that not all good bacteria are dead bacteria. If they, or some of them, are destroyers and enemies to be feared, they, or some of them,

are also helpers and colaborers to be favored.

The total number of bacteria in any soil capable of sustaining luxuriant vegetation is always very great and they vary in somewhat close proportion to the degree of fertility. In the first foot of rich garden earth about one to five millions per cubic centimeter commonly exist, though many times the larger number may be present when there is much decomposable matter and the conditions are favorable for rapid multiplication. The numbers rapidly decrease in the deeper layers, so that at three feet comparatively few are usually found, and at two or three times this depth they are practically absent. The numbers of all kinds have, however, less meaning than has the presence and activity of certain specific kinds—those which have to do with the original formation of soil and some active and efficient helpers in the maintenance of soil fertility.

ROCK REDUCERS. NITRIFIERS.

We all understand that what we term soil is not simply the crust of the earth in its original condition. The old-time rocks through long eons of time, by various agencies, have been crushed and comminuted, and the more or less pulverized materials have been mixed, transported and deposited by titanic forces and upon a scale of gigantic proportions. Mechanical agencies have been operative in the stupendous changes which have taken place in the reduction of the original rocks to the forms of sand and clays in strata as we find them, but only in recent times has it become known that certain microscopic living beings have had a share in the process. In spite of their diminutive size and of their low organization, in spite of their invisibility and of their individual nothingness, they are helpers in the accomplishment. It is customary to speak of the crumbling of exposed surfaces of rocks as due to the weather, and the process is called weathering. But in these later days it has been found that this change is largely due to living organisms, just as the decay of fruits and the putrefaction of the flesh of animals, formerly supposed to be brought about by mere exposure to the air, are now well known bacterial operations. We know now that the process of canning fruits and meats succeeds not by keeping out the air as we formerly thought, but by keeping out bacteria. In the so-called weathering of rocks and the formation from them of soil, it is not so much the air, the rain, the frost, etc., which perform the work as it is our minute friends the bacteria.

Until recently it was supposed to be impossible that any bacteria could live without organic food supplies. It is and has been well known that green vegetation builds up organic matter from inorganic compounds under the energizing agency of sunshine. For instance, starch is formed in green leaves from carbon dioxide and water—the former absorbed from the air and the latter taken up by the roots; and there is no other way known to man by which starch is formed from elementary materials. A very large proportion of our food and that of all animals consists of starchy products so primarily produced, hence the operation is an immensely important one and all due to green leaves. They are almost miracle workers, but it had not been imagined that colorless bacteria could in any measure share with these higher forms of plant life as miracle-working agencies in this respect. Yet these bacteria that live on bare rocks get their sustenance from these and from the air, and in their life processes actually store up organic matter. That is, they are soil makers, fertility producers, advance agents

in the making of a farm. They absorb and utilize the carbon dioxide of the air and when they die the carbonaceous compounds so formed are in part left as a component of what we call the humus element of soil. These bacteria are thus actively engaged in reducing the mineral substances to a pulverized form and as actively helping to provide a store of organic matter towards the formation of soil suitable for higher plants. It is remarkable, too, that these organisms are capable of accomplishing this work in the dark. As they do not derive their energy from light, as is the case with green plants, they must utilize some other radiant force or form of force for this purpose, possibly heat rays, or others not so well understood; or it is suggested that they derive their energy directly from the oxidizing processes they set up. At all events, they are wonder-working little creatures.

But our story concerning these particular kinds is not all told. Most micro-organisms acting upon nitrogenous matters are destroyers of these compounds in such sense that the substances are rendered less available as food for higher plants. They are *denitrifying* agents. These peculiar species do just the reverse. They put nitrogenous compounds which are little or not at all utilized by higher vegetation in available shape and so contribute to soil fertility in another way. They can absorb ammoniacal gas washed by rains from the atmosphere or they can act upon insoluble salts of ammonia existing in the soil and form nitrites first, and then nitrates, in which latter condition common plants can use them. This is called *nitrification*, and the bacteria nitrifying agents. There are two groups of these workers. One set of species oxidize ammonia or its compounds to nitrites and another set further change these nitrites to nitrates. A very curious thing is that these bacteria are not able to exert their activities in the presence of soluble organic matter—the very condition most favorable for most other micro-organisms. Even ammonia in a free state is an antiseptic to the nitrate formers. Soil that is liberally supplied with actively decomposing organic matter may have an abundance of these latter bacteria, but they are practically inactive until the decomposition has passed certain stages of its process. In the meantime this soil may be poorly suited for crops until later when the nitrifying processes are resumed. Denitrification can go on in a compact soil, but nitrification requires air. It seems that the stimulating effect of tillage is very considerably due to nitrifying activity, so induced; that is, we cultivate soil in part to favor these peculiar bacteriological friends. We see too how tile drainage may indirectly improve the productive capacity of the soil by securing better penetration of air and so again aid our friends, the nitrifiers. Again, these latter can not work in an acid medium. Sometimes the application of lime to certain soils proves to be greatly advantageous, not perhaps because there is too little of this substance for plant food, but because it corrects the acidity and permits, among other things, the nitrifying bacteria to work. Possibly in the full development of agricultural science there will be found more direct methods of securing the voluntary services, to their highest efficiency, of these minute friends of man.

It should be said that these nitrifying bacteria appear to be always present in all soils in sufficient numbers, hence there is little reason to suppose that anything can be gained by the addition of artificial cultures or of impregnated earth—processes which may be decidedly helpful in the case of certain other bacteria to be spoken of later—but it seems evident enough that

methods of soil management have much to do in favoring or hindering the activities of these helpful little creatures. Some day farmers will come to understand that specialists working in laboratories and who for long hours gaze through the microscope are gradually gaining knowledge of fundamental importance to them.

ROOT-TUBERCLE BACTERIA.

As has been said, there are astonishing numbers of bacteria in all fertile soils, often attaining many millions in a little cube one centimeter (two fifth inch) in diameter, and numerous different kinds have been identified. Each of these kinds has certain special activities as well as peculiar structural characteristics. Most of them are concerned in the decomposition of organic matter and in this sense are destroyers, though we must not by any means call them enemies. If they do cause the fermentation or putrefaction of organic substances, these very operations are widely advantageous, since by this means useless materials are put out of the way or, perhaps, are converted into forms of utility. In this way the humus ingredient of fertile soils is mainly supplied.

But most of these innumerable organisms do not add anything to the soils, they simply change the state or condition of matters previously present. This is true of the nitrifying kinds mentioned above except that they do absorb the carbon dioxide of the air and contribute carbon to the soil in the solid form—a slim advantage, however, in the case of soils already formed, since green-leaved plants accomplish this on a much larger scale. The nitrifying bacteria are decidedly useful little creatures because of the desirable changes they bring to pass in organic materials present in the soil, not because of any contributions from an outside source through their agency.

There are, however, other peculiar bacteria not everywhere present among the hosts of living organisms commonly at home in fertile soils which do aid in such additions. If they are peculiar in distribution they are apparently more peculiar in their mode of action and in the results produced. After much careful investigation and no little difference of opinion it has been conclusively settled that green vegetation can not make direct use of the free nitrogen of the air, though combined nitrogen, mostly in the form of nitrates, is absolutely essential to their life and growth. These nitrates are freely soluble in water and tend to leach away. If, therefore, we should return to the soil everything that grows upon it, we should still find fertility decreasing, unless in some way nitrogen could be added from an extraneous source. The store of this substance is not inexhaustible in any soil. In spite of any contributions which could be made from the products of the soil itself, whether these were first fed to animals or not, this essential element of fertility would considerably and constantly diminish. A small amount of ammonia, the product of fermenting matters or of electric combinations, is washed from the air by rain, but too little seriously to affect the problem of the maintenance of soil fertility.

Now we know that soils in nature have not deteriorated. Without help from man they have, through thousands of years, gained instead of lost their nitrogenous supplies; though it must be true that great losses have in the meantime occurred by drainage. There must, therefore, be some means of supply, some accession from without which more than balances the losses. If green vegetation can not absorb and combine the free nitrogen of the air, of which the quantity is practically unlimited, something else must do so.

During the twenty-five years from 1866 to 1891 observations and experiments by several investigators upon peculiar swellings on the roots, especially of leguminous or pod-bearing plants, resulted in showing that these are inhabited by bacteria, and that the green plants having them do in some way gain their needed nitrogen from the air when it is not available from the soil. This was a great discovery. It had long been known that these plants rendered soil more fertile for other crops afterward grown on the same land, and rotations had long been practised with clover as one of the crops for its fertilizing effects. How the clover acted as a fertilizer was not known until about fifteen years ago. Since that time our knowledge upon the subject has very considerably increased and every year now something more is learned.

The facts seem to be in general somewhat as follows: leguminous plants unaided have no more ability to help themselves to the nitrogen of the air under any circumstances than have other green plants. Certain bacteria existing in the soil penetrate the soft tissues of young roots of legumes and multiply within these living tissues so as to form a little mass of gelatinous substance. Responding to the irritation produced, the plant builds a nodular structure about the bacterial invaders, not unlike the formation of a gall consequent upon the sting of an insect. Numerous nodules may be formed on the roots of one plant and they have characteristics peculiar to the species of plant on which they occur. Some are characteristically much larger than others, varying from the size of the smallest seeds to more than that of garden peas, or they grow in different shapes, or have different forms of grouping, etc. In some way not well understood these plants with nodules or tubercles are capable of getting sufficient nitrogen from the air abundantly to serve their purposes when the soil has no supplies, and when other plants must die from the want of it. Either the bacteria are direct agents in the process or they aid the plant itself to do what without such aid it can not do.

The number of bacteria in one of these root tubercles is very large, altogether countless, yet the total number thus dwelling within the roots is insignificant when compared with the number in the soil outside. But these in the root are specifically different from those, and seem to have a decidedly different office to fulfil. As was said above, they are not common soil bacteria. They may, and sometimes do, live even some years in the soil outside of living roots, but they never become numerous among the other kinds and are often entirely wanting, however rich the soil may be otherwise.

There is a disputed question whether these root-dwelling bacteria all belong to one species with some temporary variation into races each adapted to a special kind of leguminous plant, or whether there are numerous species, almost as many as there are genera of legumes, upon which they are found. This may be thought to be an unprofitable inquiry, but it may mean more than we see at first glance. There is no longer any question but that there is some kind of difference among them. Those that form tubercles on the roots of clover fail entirely to develop on garden peas and on soy beans, and those that accompany soy beans appear to have no effect upon alfalfa. Some of them grow differently in artificial cultures and appear to have, under the microscope, various different characteristics. In certain instances it has been shown, however, that kinds usually associated with certain legumes can become adapted to others which they did not previously accompany, and this has been held

to mean that in all cases the recognized form and functional differences are temporary modifications and that all are one natural species. There is really a very important matter here which we trust we shall soon know more about. If those which normally inhabit one species of leguminous plants can be modified by artificial cultures so as to grow upon another species of legumes, may further modifications be induced so that growth may take place upon some plant not a legume? There is no known reason why legumes particularly are hosts of these organisms to the exclusion of other kinds of vegetation. As a matter of fact, there are other and very different kinds of plants upon which similar root tubercles are found, namely, shrubs or trees of the genus *Alnus* or alder (not elder); two or three species of the family Eleagnaceæ, European shrubs sometimes cultivated with us for their silvery foliage; and—what appears more strange—upon coniferous trees of the southern hemisphere belonging to the genus *Podocarpus*. It has now become well known that the root tubercle organisms peculiar to alfalfa are not very widely distributed in our country and that in many cases the former can not be profitably raised without artificial inoculation of the soil. In such cases a remedy is found in scattering earth taken from a field where the plant has been successfully grown and where the nodules on the roots have been observed. A similar statement may be made with reference to soy beans, and there are areas, though not so common, where the bacteria which form tubercles on the roots of clover do not exist. In such areas the clover plant no more contributes to soil fertility than do other kinds of green vegetation.

We have asked: Can these legume organisms or some of them be made to form tubercles on other plants, for instance, upon maize? Here is a matter of the greatest moment. Undoubtedly they have some time in the past become adapted to leguminous vegetation. There is nothing to prevent the supposition that they may possibly be made to adjust themselves to corn. If so, what a triumph this would be for scientific experimentation. What an advance it would mark for scientific agriculture. We know that corn can be very decidedly modified in its chemical composition by processes of breeding. Types of grain can be produced in which, for instance, the nitrogenous percentage is greatly increased, and so a long way improved as food for man and beast. If, in addition to this, Indian corn can be made to furnish itself, through accommodating bacteria, with this higher nitrogen content directly from the exhaustless storehouse of the air, the agricultural miracle of the age will have been wrought. No one can predict whether or not this will ever come to pass. But from what is now known the endeavor to bring it to pass seems at least worth while.

Some years ago there were put up in certain German laboratories substances under the name of *nitragin* which were supposed to be pure cultures of living bacteria severally suitable for different leguminous crops, and it was thought that great results would follow the proper application of these cultures to fields seeded with the various legumes. Patents were taken out in Europe and in this country protecting the manufacture and use of these substances, but little seems to have come of the matter. Now the Department of Agriculture at Washington is sending out what are supposed to be improved cultures for a similar purpose, and some very favorable reports of their use have been made. It is too soon to determine how valuable the results are

to be. Surely tests are abundantly worth trying.

NITROGEN FIXATION BY FREE BACTERIA.

It was asserted above that little is known of the method by which leguminous plants in connection with root-tubercle bacteria accumulate nitrogen. It remains to be said that some experiments have shown that these same bacteria in artificial cultures can of themselves absorb and combine aërial nitrogen; that is, the legume bacteria are nitrogen fixers without any aid from leguminous plants. There is no proof, however, that this is done in nature, that these organisms, while in the soil outside of the root tissues, appropriate free nitrogen and build it into compounds which become suitable for plant food. It is, however, known that some other bacteria, not tubercle formers, do accomplish this task, for in unsterilized soils free from green vegetation an increase in the nitrogen content is found to take place under circumstances which preclude the accession except from the free nitrogen of the air; while in sterilized soils of the same kind under the same conditions no increase occurs. Since there is nothing else but bacteria in the unsterilized soil to which the phenomenon can be attributed, search has been carefully made for the active agents. After many tests upon numerous soil-inhabiting species, certain kinds of bacteria have been found which undoubtedly have the power of building the aërial nitrogen into combinations which subsequently serve as food for higher plants. In this case we must understand that the process is accomplished solely by the bacteria, and it is by different species from those forming root tubercles. In fact, several different kinds of bacteria and some molds are now known which thus contribute to soil fertility, but in most cases the quantity of nitrogen fixed is very small.

Two species, however, have been discovered which are apparently very efficient in the process, viz., *Clostridium Pasteurianum* Parzm. and *Bacillus Ellenbachiensis* Stutzer-Hartleb, and an artificially prepared substance called *alinit* has been placed on sale in Germany which appears to be a pure culture of the latter. Practical tests with alinit have not upon the whole shown that its application to soils results in any considerable increase in crops, though in some instances favorable reports have been made. The discovery that the organism has under some conditions the effect of reducing nitrates to nitrites makes it seem less certain that the commercial preparation will prove valuable.

Here we pause. Our story has been a long one, yet only a meager account has been given of some of those soil bacteria which are efficient agents in preparing for, or furnishing, higher vegetation an essential constituent of their food. We have seen that in the most sterile soils certain nitrifying organisms are constantly at work utilizing ammonia washed from the atmosphere by rains or converting ammonia salts into nitrites, which are in turn oxidized by other species of bacteria into nitrates, the form suitable for the sustenance of higher vegetation. Again, the root-tubercle bacteria make a way for leguminous plants to use the free nitrogen of the air and to build up in their own structures compounds which contribute essentially to the fertility of the land when these structures decay. And then certain other soil bacteria are direct agents in the binding of free nitrogen into complex combinations within their own bodies, which upon their death are fitted by the agency of other bacteria to combine with the mineral constituents of the soil, to the effect that fertility is increased, even where the apparently bare earth seems lying idle, wasting in the sun.

While these particular operations are in progress countless hoards of bacteria of various kinds are each exercising their natural functions in the rôle of destroyers or helpers, as the case may be. Surely we may think of the soil as a factory full of busy workers, causing incessant changes and modifications, rather than as a simple storehouse of accumulated riches.

The prosperity of peoples depends upon other factors than the fertility of the soil on which their homes are made, but those countries which are naturally most fertile furnish man more easily and more abundantly those things which may be used by him in increasing his power and in promoting his highest interests. In Illinois the local passenger traffic on the railroads is found to vary conspicuously with the difference over large areas in the quality of the soil, though all of the country is well populated. Not only is the number of the passengers in the regions of the best soils several times greater, but the difference in character of the men and women is also evident. The towns in the one case have great business houses, elegant residences, paved streets, electric railroads and lights, fine churches and school-houses, and a progressive, strong, hopeful and happy populace; while in the other these things are noticeably wanting, except in some measure the numbers of people. These take unconsciously a slower step, require more time in which to transact business and have less relish for physical or mental activity. They are evidently not so well fed and are in consequence really less capable of sustained exertion. Then, too, there is a stimulus in success itself which animates and inspires, while hopefulness is half the battle. Repeated failure of crops not only discourages the husbandman, but robs the entire community of life and push, and this is as true of mental and moral as of physical activities. Soil fertility and man's virility are closely related. Therefore, since certain bacteria have been proved to have direct and very important connection with the former, they have in like measure evident and decided bearing upon the latter. If all flesh is grass, all nutrition as applied to man seems to be ultimately conditioned upon the activity of certain micro-organisms of the soil.

Man has proved himself to be a mighty master. Formerly the storm-tossed oceans toyed like bubbles with his contrivances and the great billows were barriers to navigation. Now the tempestuous waters are luxuriant pathways of travel, and down in their silent depths they pulsate from shore to shore with vibrant intelligence. Continents are spanned with iron and the massive locomotives thunder over the rivers and plunge under the mountains, defiant of opposition but delicately responsive to human control. How man has swept the forests from the face of the globe, and made at his will the wilderness to blossom as the rose! The earth, the air, the waters have yielded to him their secrets and the forces thereof have become the obedient servants of his commands. But master as he is, potent as is his sway, he never could have gained a livelihood, nor could he now long maintain existence on the earth, without the aid of myriads of invisible, though organized and living, silent though industrious and efficient agents of the microscopic world. It becomes him, therefore, to seek acquaintance with these beneficent creatures and to find ways and means of favoring their life-giving activities.

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SCIENTIFIC BOOKS.

The Classification of Flowering Plants. By Alfred Barton Rendle, M.A., D.Sc., F.L.S., assistant in the department of botany, Brit-

ish Museum, and lecturer in botany at the Birkbeck College. Vol. I., Gymnosperms and Monocotyledons. Cambridge, at the University Press. 1904. Pp. xiv + 403. 8vo. 187 figures in the text.

The purpose of this book is stated by the author to be 'an attempt to give the student who has some acquaintance with the rudiments of botany a systematic account of the flowering plants.' By 'flowering plants' Dr. Rendle here means the seed plants, so that the pines, cedars, yews and their relatives are included under the term. That the author does not himself agree with this grouping is clearly shown in the preface, where he goes so far even as to doubt the paramount value of the seed character in classification. However, after expressing this doubt, he concludes 'on the present occasion' to treat the gymnosperms (pines, cedars, yews, etc.) and angiosperms (lilies, grasses, buttercups, pinks, mints, roses, parsleys and sunflowers) as parts of a single great group.

The first chapter, of about thirty pages, is given to a short historical statement of the development of plant classification. While brief, this is a useful summary, especially for those not having access to considerable libraries. The treatment is quite unequal. Thus a half page each is allotted to Robert Brown and John Lindley, and but a page to Endlicher, while to Van Tieghem and his singular systems are given more than five and a half pages. The system adopted by the author is essentially that of Engler in the third edition of his 'Syllabus der Pflanzenfamilien.'

The book is logically arranged, beginning with those groups which the author considers to be lower and primitive. Thus we have taken up first a discussion of the structure of the reproductive and vegetative organs of the Cordaitales, extinct since the Carboniferous period. Naturally the treatment is brief and incomplete for want of good material, but it must be said that the author has made the most of the little that we know of these primitive gymnosperms. Then follows a longer chapter on the Cycadales, in which the author confines his discussion wholly to the living forms. Next comes a short chapter on Bennettitales, extinct since the Mesozoic period, followed by one on Ginkgoales, based mainly upon the single living, *Ginkgo biloba*, but with some reference to extinct species. In passing it may be noted that Dr. Rendle considers the structures on which the ovules of *Ginkgo* are borne to be axial. We much prefer Van Tieghem's interpretation of these structures as foliar in nature. The chapter on the Coniferales is by far the longest, as it should be. The usual morphological views are adopted, and the grouping of the genera is quite like that with which we are familiar. In regard to the nature of the seed-scale of the pines and their allies, the views of many investigators are given, and the whole is summed up by the statement that 'the view that the scale and ovule represent a secondary axis arising in the axis of the bract is at present the most generally accepted one.' In the treatment of Gnetales there is nothing new. The acceptance of the name *Tumboa* (instead of *Welwitschia*) is significant. A few years ago such an application of the 'law of priority' would have been most unlikely.

In taking up the angiosperms about fifty pages are given to a chapter devoted to their general morphology, in which we have considerable injection of modern morphology and terminology into what is for the most part a treatment along old lines. In reading the pages of this chapter one is impressed with the feeling that the author is condensing and abbreviating his discussion, with a consequent loss of clearness. For the student who has no more than 'some acquaintance with the rudiments of botany' many of the statements of the author will not be understood, and will have to be supplemented by much elucidation at the hands of his instructor.

The chapter dealing with the monocotyledons is well worked out, about two hundred pages being given to their morphology and classification. Following Engler's system the Pandanales are taken up first, with the remark that in them 'the flower is extremely indefinite' and that 'we have here presumably a primitive condition, prior to the evolution of the more typical arrangement.' The Helobieæ follow with the usual treatment, in-

cluding the Hydocharideæ. Under the Glumifloræ the grasses (Gramineæ) are described as having a solitary carpel, which is certainly an error for the three-styled genera, and probably so for those with two styles. Hackel's arrangement is followed. Curiously, in the sedges (Cyperaceæ) the carpels are described as 'three or two.' How these two views as to the nature of the pistil can be harmonized is difficult to make out.

The palms and aroids (Principes and Spathifloræ of Engler) are united into the 'series' Spadicifloræ. A curious typographical error occurs on page 250 (and is repeated on page 256) where the number of species of palms is given as 11,000! The treatment of the remaining groups (Farinosæ, Liliifloræ, Scitamineæ and Microspermæ) is in all essentials in accordance with that in Engler's 'Syllabus.'

The final chapter is devoted to a general review and to suggestions of affinities between the groups. This has not been well wrought out, and the student will be much confused by some of the statements. For example, while we are told that 'the Glumifloræ represent a primitive type,' and 'we may regard them as the stock from which the higher series have been derived,' we are told over and over again that the grasses are highly specialized. The diagram at the close of the chapter, while helpful in enabling us to understand the author's position, will scarcely help the student to an understanding of nature. According to it there are three monocotyledonous phyla, viz., (1) Helobieæ, (2) Pandanales, Spadicifloræ, (3) Glumifloræ, Farinosæ, Liliifloræ, Scitamineæ, Microspermæ.

Throughout the book, 'order' of Engler is given as 'series,' and 'family' as 'order,' in deference to time-honored English usage. Here again we prefer the German practise.

The book will be useful, and while it has defects, it is the result of much painstaking work, and must prove helpful to other workers.

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Discussion and Correspondence.

Currents of the North Pacific.

To the Editor of Science: I read with interest Dr. Bishop's letter on the source of the Pacific Coast current, and the hypothesis he proposes to account for it, in Science, of September 9.

The writer, like many others who have touched on ocean currents, does not make clear the distinction between the general system of oceanic circulation and ocean currents strictly so called.

The former is influenced by the rotation of the earth, differences of specific gravity and temperature in the oceanic mass, tides, the pressure of the atmosphere and various minor causes. The movement of Antarctic water northward in the Pacific belongs in this category, and we have no observations on record which would lead us to believe that the movement is other than very slow and gradual, or that it has any marked effect in producing the superficial streams of rapidly moving water which we call currents.

Oceanic currents are produced by the winds, by atmospheric pressure, and by the tides, modified by the presence of bodies of land. Permanent currents are due almost wholly to friction of permanent currents of air like the trade winds.

Dr. Bishop is quite right in supposing that the Kuro Siwo, like the Gulf Stream, does not extend across the ocean in which it originates. Nevertheless, the water of both, but especially of the Gulf Stream, has been traced thousands of miles beyond the point where the stream, *as a current*, has disappeared. It has been carried by the prevalent winds aided by the oceanic circulation.

The most complete collection of data for the North Pacific together with a discussion and chart may be found by Dr. Bishop in the report of the U. S. Coast Survey for 1880, Appendix No. 16, published in 1882, and to which little in the way of current data for the North Pacific has since been added.

The northwest trades, blowing hard and steadily for ten months in the year, carry the warm water, which the Kuro Siwo delivers in mid-ocean, to the northwest coast, which it

reaches about latitude 54° and there divides into a northerly and southerly stream. At this point the maximum temperature of the water is 65° F., but the average about 60° F. As it moves down the coast it loses its heat and produces the rains and fogs of the Oregonian region, cooling off so that when it reaches the latitude of the Golden Gate it has only the temperature of 54°, or thereabouts, and is colder than the normal sea water for that latitude. It continues southward as a cold current as described by Dr. Bishop. That this essentially superficial stream is not due directly to the impinging of cold Antarctic water on the northwest coast seems to be certain from the fact that the temperature of the latter is only 32° F., while the current, when it first reaches the coast, is thirty degrees or more warmer than that; and also that the water of the current is *warmer* in latitude 54° than it is in the more southern part of its course, whereas, if it was abyssal water we should expect it to be colder and to gradually warm up as it moved southward exposed to the action of the sun.

WM. H. DALL.

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.,
September 12, 1904.

SPECIAL ARTICLES.

ON THE PUPATION OF ANTS AND THE FEASIBILITY OF ESTABLISHING THE GUATEMALAN KELEP OR COTTON-WEEVIL ANT IN THE UNITED STATES.

IN a recent number of SCIENCE Dr. O. F. Cook publishes some of Mr. G. P. Goll's observations on the cocoon-formation of the kelep ant (*Ectatomma tuberculatum* Oliv.), apparently in the belief that similar observations have not been made on ants with enclosed pupæ. As a matter of fact, it has been known for some time that such ants bury their mature larvæ in the soil till they spin their cocoons and then, after some hours or days, unearth them and cleanse the outer surface of their envelopes. This habit has been repeatedly described for European species of *Formica*, especially by Wasmann.* It is, of course, a necessary habit, as pointed out by Dr. Cook, since the larva must have some support for the threads spun from its sericteries. In default of earth, as when ants (species of Camponotinæ or Ponerinæ) are kept in glass nests of the Fielde pattern, the workers tear off bits of sponge or toweling to spread over the larvæ as a support for the cocoon. If such materials can not be obtained, or if the larvæ are much disturbed while spinning, they will form free pupæ. I have seen this repeatedly in the case of mixed colonies of our American amazons (*Polyergus breviceps*, *P. bicolor* and *P. lucidus*) and their slaves, and in *Odontomachus clarus* and *Pachycondyla harpax* (a species allied to the kelep ant). The habit has been emphasized by Wasmann because it is of importance in his discovery of the interesting relations of *Formica* to the parasitic beetles *Lomechusa* and *Atemeles*:

> Both *Lomechusa* and *Atemeles* larvæ are assisted in their pupation by their hosts, exactly as are the ant larvæ. The adopted larva is placed on some soft sand, and while it moves the anterior portion of the body slowly to and fro, it is surrounded with a ring of earth, which is soon built over it like an arched roof. Within this the adopted larva spins a very fine web which merely keeps the surrounding sand particles together.
>
> This is the critical moment in the development of the *Atemeles* and *Lomechusa*. The ants are in the habit after a few days of unearthing their own larvæ which spin a dense, tough cocoon, in order to cleanse and stack up the cocoons. They attempt the same with the adopted larvæ, unfortunately, since they are thereby prevented from pupating and perish, if they are not again buried and left to themselves. Only such adopted larvæ develop, as are forgotten by the ants after they have been embedded. For this reason I obtained only one imago from thirty *Lomechusa* larvæ and not a single one from more than fifty *Atemeles* larvæ.

In this connection it is perhaps timely to call attention to the fact that C. Janet* some years ago emphasized the bearing of the presence and absence of the cocoon in ants on the

* See, *e. g.*, his 'Vergleichende Studien über Ameisen- und Termitengäste,' Haag, 1890, p. 95 *et al.*, up to his recent article: 'Zur Kontroverse über die psychischen Fähigkeiten der Ameisen,' *Natur und Schule*, Bd. 3, 1904.

* 'Les Fourmis,' *Soc. Zool. de France*, Conf. 28, Fév. 1896, Paris, 1896, pp. 3, 4.

theory of development by discontinuous variations, or mutations as they are now called:

> We are without doubt confronted in the ants with the disappearance of this protective envelope [the cocoon] which has become unnecessary through the incessant care lavished on the progeny by the workers.
>
> From the point of view of the evolution of instinct it is interesting to observe that this disappearance does not take place gradually by evanescence of the cocoon, but suddenly, so to speak, since larvæ which are similar to one another and produce similar adults, either make an absolutely complete cocoon, without any signs of reduction, or make none at all.
>
> This fact may be cited to show how sudden may be the changes that supervene in the habits of an animal. It supports the conclusions announced in a communication by my brother, M. Armand Janet, to the congress at Leyden. These conclusions, deduced from considerations of rational mechanics applied to the problem of species regarded as a position of equilibrium, tend to demonstrate that the differences between a certain form and its descendants are produced rather by quite sudden leaps than by insensible and continuous variations.

Much has been published of late, both by the government and the newspapers, concerning the advisability and feasibility of establishing the kelep ant in Texas and the other cotton-growing states for the purpose of destroying the boll-weevil. I feel at liberty to comment on this subject because for some years past I have had rather exceptional opportunities in Texas, Florida, Mexico and the Bahamas of studying the habits of a number of species belonging to the same natural subfamily as the kelep. This study has convinced me that the attempt to establish the ant in Texas will prove to be about as successful and profitable as an attempt to acclimatize in the same state some rare Central American orchid, the South African secretary bird or the Australian wombat. But in undertaking to give my reasons for this opinion, I am far from wishing that the experiment were not being tried. An experiment may, of course, be a complete failure from a purely economic standpoint and still be of considerable, albeit negative, scientific value.

At the outset I may say that I have not myself studied the living *Ectatomma tuberculatum*, though I am familiar with the insect in collections.* But Dr. Cook's account† shows that in all essential particulars its habits are the same as those of other Ponerinæ.‡

The peculiarities which the kelep shares with other Ponerinæ and which would seem to place serious obstacles in the way of establishing it in a foreign country, are the following:

1. The Ponerinæ are archaic ants which form small colonies§ and comprise no dominant species except in Australia, where the genus *Myrmecia* (the famous 'bull-dog ants') offers an interesting and instructive parallel to the marsupialia among mammals. In fact, the opossums of America bear about the same relation to our dominant mammals, like the rodents, as do the Ponerinæ to the dominant ants of the subfamilies Myrmicinæ and Camponotinæ.

2. The Ponerinæ are local and rare, and show little adaptability or plasticity in comparison with the more recently evolved and dominant species.

3. It is altogether exceptional for any of the Ponerinæ to restrict their diet to a single species of prey. In fact, the only known exception is the Texan *Leptogenys elongata*, which, as I have shown, feeds very largely, if not exclusively, on terrestrial isopods.¶ The kelep is described by Dr. Cook as capturing and consuming 'adult insects of many and diverse kinds,' so that we may be sure that it

* Dr. Cook is in error in supposing that there is anything doubtful about the occurrence of *E. tuberculatum* in Mexico. I have before me a fine series of workers taken at Tuxpan by Mr. J. F. McClendon. They agree perfectly with a typical specimen of the kelep collected by Stoll, at Retalhuleu, Guatemala, and sent me by Professor Forel.

† 'Report on the Habits of the Kelep, or Guatemalan Cotton-Boll-Weevil Ant,' U. S. Dept. Agr. Bur. Bull. No. 49, Washington, 1904.

‡ See my papers, 'A Study of Some Texan Ponerinæ,' *Biol. Bull.*, Vol. II., No. 1, 1900, and 'The Habits of *Ponera* and *Stigmatomma*,' *ibid.*, Vol. II., No. 2, 1900.

§ *E. tuberculatum* colonies contain from 20 to 110 workers each, and average between 40 and 50.

¶ 'A Crustacean-eating Ant (*Leptogenys elongata* Buckley),' *Biol. Bull.*, Vol. VI., 1904.

will not confine itself to boll-weevils, even if it succeeds in surviving the winters and floods of Texas. If we except a few vegetarian species like the curiously modified fungus-growing Attii, ants, like human beings, thrive best on a varied diet. Cook says that 'The discovery of the ant [the kelep] supplies a practical reason for the existence of the nectaries [of the cotton plant] hitherto quite unsuspected, and it suggests the further possibility that the weevil and the ant have been factors in the evolution of the cotton plant, for the weevil is not known to feed on any plant except cotton.' This statement is clearly at variance with the current views of many botanists and myrmecologists, who have compared the much exaggerated and largely fictitious accounts of the dependence of plants on protecting ants with the actual conditions.* Furthermore, even if we accept the views of Schimper and some other botanists in regard to the protection afforded plants by these insects, we should still be unable to understand why the boll-weevil was not long ago exterminated by the kelep, inasmuch as the beetle is clearly injurious to the cotton plant and hence to the supposed best interest of the ant.

The above considerations indicate that there is little probability that the kelep can be successfully established in Texas or adjoining states, or, if established, that it will be an appreciable factor in the extermination of the boll-weevil. This becomes even clearer if we glance for a moment at the more general subject of the introduction of ants into foreign countries. At first blush ants would seem to be the easiest of all insects to introduce, since the fertilized queen is long-lived and capable as an individual of producing a whole colony of all the three sexual forms so characteristic of these and other social insects. Moreover, the young brood is efficiently protected from danger by the workers and not left to shift for itself as in most insects. But when we come to enumerate the species that have been able to survive in foreign lands, we find it to be very small, limited to a few genera and comprising several more or less dubious cases. In my opinion the following are all the foreign ants that can be supposed to have established themselves in this country since it was opened up to commerce: *Tetramorium cæspitum, T. guineense* and *T. simillimum; Monomorium pharaonis, M. floricola; Pheidole megacephala, Prenolepis longicornis; P. pubens; Plagiolepis longipes,* and some doubt attaches to all of these forms except *M. pharaonis,* the tiny yellow house-ant of Old World origin. It is an open question whether *T. cæspitum* has been introduced into the United States. It seems to occur only along the Atlantic coast from Connecticut to Maryland, but it is quite possible that it may be indigenous. The remaining species in the above list are all tropicopolitan and may all be indigenous to the tropical and subtropical portions of our continent, for the conditions in these regions are much more generally favorable to ant-life than they are in temperate regions. All of these species are occasionally met with in our northern green-houses.*

Considering the ease with which incipient ant colonies and single fertilized queens are carried from one country to another in wood, hot-house plants, soil, minerals, etc., this list is surprisingly meager, even if there were sufficient evidence to prove that the species enumerated are all *bona fide* importations. Incidentally it should be noticed that none of these are Ponerinæ, but all belong to the two dominant subfamilies, the Myrmicinæ and Camponotinæ.†

One of the reasons for this small number of imported Formicidæ would seem to be the extreme sensitiveness of these insects to

* See, *e. g.*, the excellent article by Ernest Rettig, 'Ameisenpflanzen—Pflanzenameisen: Ein Beitrag zur Kenntnis der von Ameisen bewohnten Pflanzen und der Beziehungen zwischen beiden,' Jena, Gustav Fischer, 1904.

* Further study of *Formica cinerea* and *F. rufibarbis* convinces me that they can not have been imported from Europe, as I once supposed possible.

† Some idea of the number of species of ants accidentally introduced with hot-house plants at a single port (Hamburg), may be obtained from two of Forel's recent papers: 'Fourmis Importées,' *Bull. Soc. Ent. Suisse.*, Vol. 10, 7, pp. 284–287, 1900, and 'Formiciden des Naturhistorischen Museums zu Hamburg, *Mitth. a. d. Naturhist. Mus.*, 18, 1901. Anhang., pp. 78–82.

physical conditions such as soil, moisture, sunlight, etc. No animals exhibit finer geographical variations or depend more completely on a very precise environment. While a certain and even considerable range of adaptability to varying conditions undoubtedly exists in many of the species, this is confined to dominant forms, like certain Myrmicinæ and Camponotinæ, and does not extend to the archaic and relict Ponerinæ, even the most variable of which, like *Odontomachus*, are peculiarly specialized and lacking in plasticity.

But even if the physical conditions of Texas and the other southern states prove to be favorable, it is certain that the kelep will have to reckon with the ant fauna already existing in this region, and in no state of the union is this so extensive and so formidable as in Texas. It is, indeed, probable that the living will be an even greater danger than the physical environment to a species which is very far from being a dominant faunal component even in its native land.

Dr. Cook makes the statement that 'the kelep is as yet the only ant known to attack and destroy healthy boll-weevils.' A few years ago Professor A. Herrera, of the City of Mexico, sent me for identification a species of ant which he found attacking the boll-weevil. I am not sure that he has published any observations on this insect,* which occurs from Colorado through Texas into Mexico, but seems not to be found east of the Pecos River. It may be seen at its best at Fort Davis, Texas, where it forms enormous colonies in grassy places about the cotton wood trees along the arroyos. Although it is extremely predatory and pugnacious, it does not sting. Of course, it is doubtful whether this ant could be induced to live in the cotton-growing portions of Texas, but it seems to me that it would be a better form for experimentation than the kelep, if, as Professor Herrera seems to have found, it really attacks the boll-weevil.

William Morton Wheeler.

American Museum of Natural History,
September 5, 1904.

* Described by me as *Formica subpolita* Mayr var. *perpilosa*. *Mem. y Rev. de la Soc. Cient.*, 'Antonio Alzate,' Vol. 17, 1902, p. 141.

CURRENT NOTES ON METEOROLOGY.

GENERAL CIRCULATION OF THE ATMOSPHERE.

Dr. W. N. Shaw read a paper on the 'General Circulation of the Atmosphere in Middle and Higher Latitudes' before the Royal Society, on June 2, which he summarizes in *Nature* for July 7. The isobars computed by de Bort for 4,000 meters above sea level indicate a comparatively simple steady motion around the polar axis from west to east, somewhat deflected to south or north by land or sea areas. The computed velocities of air movement on the gradients at this level are not at all unreasonable, and the directions of motion are appropriate, and are confirmed in Hildebrandsson's report on cloud motion. When the weight of the stratum of air between 4,000 meters and sea level is charted by means of sea level isobars, a circulation of the atmosphere from east to west around the cold pole in each hemisphere is indicated. The general surface pressures may, therefore, be resolved into two components, one due to the upper stratum above 4,000 meters which, alone, would produce a general circulation from west to east around the minima of pressure near the poles. The other, due to the lower stratum, if acting alone would produce a circulation from east to west. Both circulations would correspond closely with the surface distribution of isotherms. Where the one is predominant, in the lower middle latitudes, we get a resultant westerly circulation; where the other is predominant, near the poles of cold, we get an easterly circulation. And between the two there is a region of minimum pressure and a merging of the two circulations, which gives rise to the cyclonic storms of the north and south temperate zones. In the lower air the caps of relatively cold air in the polar regions stop the westerly currents which still flow in the lower latitudes, and replace them by currents from the east. Between these two currents mixing takes place, and eddies may be formed.

JAPANESE METEOROLOGICAL OBSERVATORY.

Bulletin No. 1 (1904) of the Central Meteorological Observatory of Japan, contains the following papers: 'Observations of the Earth

Temperature at Tokio,' by W. Oishi, based on the records taken between 1886 and 1902; 'Température moyenne annuelle de la Surface de la Mer dans l'Océan Pacifique Occidental,' by Y. Wada, based on observations from 1882 to 1901, and illustrated by means of monthly and annual isothermal charts; 'The Epochs of the First Ice in Japan for 1902,' by T. Okada, with a chart; and 'Evaporation in Japan,' by T. Okada, which is a contribution of considerable general interest and importance. The present *Bulletin* is the first of a series of publications which are to appear under the title *Bulletins of the Central Meteorological Observatory of Japan.* These bulletins are to be issued at convenient intervals, and are to contain the results of researches on meteorology and allied sciences made by the members of the observatory. It is intended that observations, and their discussion, on special subjects not included in the routine work of the service, shall also be published. The present volume, with the promise of those issues which are to follow later, indicates a high degree of activity in meteorological work in Japan.

VIENNA METEOROLOGICAL OBSERVATORY.

THE annual volume of the *Central-Anstalt für Meteorologie und Erdmagnetismus* in Vienna (1902, date of publication 1904) gives evidence of a constantly expanding sphere of activity of this observatory, under the able directorship of Dr. J. M. Pernter. Among the noteworthy data contained in this publication are the results obtained by means of self-recording instruments on the Sonnblick and Obir (two stations); at Tragöss, the interesting 'North Foehn' station; at Beirut, Jerusalem and Port-au-Prince. Dr. Felix M. Exner has been taken on to the regular staff of the central observatory, and has also recently been appointed *Privat Docent* in meteorology at the University of Vienna. Dr. Exner recently spent several weeks in the United States, making a study of our meteorological equipment at Washington, Blue Hill and other places, and of the methods and illustrations employed in teaching meteorology at Harvard and elsewhere. His work in teaching at Vienna will help to give that city added prestige as a meteorological and climatological center. A supplement to the present volume, which was published some months ago, deals with the question of 'weather shooting,' and was reviewed in these columns.

MOUNTAIN SICKNESS.

Mosso, who has made a considerable study of the physiological effect of higher altitudes, contributed two papers to the *Atti dei Lincei,* for June 19 last, which, according to the abstract published in *Nature,* of August 4, tend to disprove the assumption that the difficulties experienced are due solely to the diminished tension of the oxygen in the air. Mosso now shows that when the barometric pressure of a mixture of oxygen and nitrogen is diminished to one third of an atmosphere, while the proportion of oxygen is increased until its partial pressure is the same as under ordinary circumstances, severe inconvenience, abnormal respiration and pulse action result. That this is not due merely to the increased proportion of oxygen has been shown by a study of the effects produced by breathing pure oxygen on the summit of Monte Rosa. Blood analyses indicate that a diminution in the proportion of carbon dioxide, caused by the low pressure, is probably responsible for the result. This view is upheld by the fact that a mixture of oxygen and carbon dioxide, containing 20 per cent. of the latter, which resulted in dizziness and nausea when breathed at Turin, was attended by sensations of ease and pleasure when breathed on Monte Rosa.

R. DEC. WARD.

NOTES ON INORGANIC CHEMISTRY.

CONDITION OF HELIUM IN PITCHBLENDE.

R. J. Moss recounts in the *Comptes Rendus* an attempt to determine the condition in which helium exists in pitchblende. The mineral was powdered in a vacuum. The chief substance set free was water vapor, and it was accompanied by small quantities of helium, carbon dioxid, nitrogen and oxygen. While about one half of the gas set free, exclusive of water, was often helium, yet the

amount was only about one per cent. of the total helium in the mineral. In one instance 0.7 per cent. of the gas obtained was hydrogen, which Moss thinks may have been the product of the action of radium upon the water present. The conclusion drawn is that the helium exists in pitchblende in a free state, enclosed in exceedingly small cavities.

HELIUM IN MINERALS FROM GREENLAND.

An investigation has been made by Julius Thomsen of the gases contained in a fluorspar from Greenland, containing fluorids of the rare earths. At a red heat a kilo of the spar gave off about 800 cubic centimeters of gas, 715 of which were carbon dioxid, probably due to the presence of ferrous carbonate. The other 85 cubic centimeters consisted of hydrogen, carbon monoxid, hydrocarbons and 24–27 cubic centimeters of helium. When the mineral was treated, prior to heating, with hydrochloric or nitric acid, or both, while the carbon dioxid was reduced to about 40 cubic centimeters, the amount of helium remained unchanged. The same was true even after treatment with concentrated sulfuric acid, or fusion with caustic potash. From these experiments Thomsen concludes that if the helium is not free, it must be present in an extraordinarily firm compound. Other minerals from Greenland containing rare earths were also examined, including steenstrupite, eudialyte and a silicate from Ivigtut, and while much gas was often evolved, no trace of helium was found. The same was true of a green fluorspar from England, which gave on heating a blue fluorescence.

CONDUCTIVITY OF RADIUM SOLUTIONS.

It would not be surprising, in view of the ionizing power and high atomic weight of radium, if its salts showed an abnormal conductivity in solution, but recent experiments of Kohlrausch and Henning indicate that this is not the case. Assuming the atomic weight of radium as 225 and working with about 8 milligrams of the bromid, they find the molecular conductivity and the migration velocity of the radium ion to be very close to that of barium, and not far from that of strontium and calcium. If the atomic weight of radium be 258, as claimed by Runge and Precht, these values become only a little higher. They consider this as a new example of the small part played by the atomic weight in determining the characteristics of a salt.

METALS IN MINERAL WATERS.

Much has been written on the therapeutic action of the heavy metals in mineral waters, and a new suggestion has been put forward by Garrigou in the *Comptes Rendus*. After submitting the water of the old Eaux-Bonnes spring to prolonged dialysis, he finds the larger part of the heavy metals in the undialyzable portion; that is, they are present in a colloidal form, doubtless in organic combination. He considers that these metallic compounds are of the nature of oxydases and play an important part in the therapeutics of mineral water. This discovery would seem also to be of importance in water analysis, since these metals would not react with the ordinary reagents for metals in solutions, and complete destruction of all organic matter in the water would thus be an indispensable preliminary step before the determination of at least any heavy metals.

ACTION OF METALS ON FERMENTATON.

An interesting series of experiments by Leopold Nathan are described in the *Centralblatt für Bakteriologie und Parisitenkunde*, made in the effort to determine how far metals and metal containers have an inhibitory action upon fermentation processes. The experiments were carried out by immersing pure metals in the form of thin cylinders in the fermenting liquid. Both cider and beer were used. In the case of cider, in general more of the metal passed into solution, but the ferment was more resistant. The liquid remained clear during and after the fermentation. Beer was much more sensitive. With the iron cylinder, a grayish sheen was visible in the liquid, which during the fermentation became inky, and finally a black precipitate appeared. German silver, copper, zinc, brass and bronze had a decidedly strong inhibitory action upon the fermentation, while tin and

lead were moderately toxic. On the other hand, polished iron, silver, gold, polished tin, aluminum, nickel and a few alloys, as well as celluloid, glass, and hard rubber, had little or no effect. In metals, the smoothness of surface seems to have a decided influence.

BIOCHEMICAL REACTIONS FOR TELLURIUM AND SELENIUM.

IT has long been known that certain microorganisms are capable not only of living in arsenic solutions, but of reducing arsenic compounds to volatile gases containing arsenic. It has indeed been supposed by many that the chief danger to be apprehended from arsenical wall papers is the production of such poisonous gases by molds. This study has been applied by Professor Gosio, of Rome, to compounds of tellurium and selenium, chiefly to tellurites and selenites. The former are much more susceptible to the action of micro-organisms than arsenic compounds, showing a decided brown or violet coloration with *Hyphomycetes* under favorable circumstances within two or three minutes. The tellurites also react with the *Schizomycetes* and various bacteria, often giving black precipitates. The compounds formed depend upon the particular kind of microorganism used. The selenites are decomposed almost as rapidly, giving with cultures of the colon bacillus a red coloration in six minutes. The coloration is probably due to the precipitation of metallic selenium. These reactions are suggested for the purpose of detecting certain microorganisms.

SOURCE OF NORMAL ARSENIC IN THE BODY.

Now that it is well established that arsenic is a normal constituent of the human body, it becomes of interest to know its source, and this problem has been studied by Gautier, to whom we owe so much of our knowledge regarding the detection and determination of minute quantities of arsenic. In conjunction with Clausmann he has analyzed a large number of foods, and the following are some of his results. The figures represent the number of micrograms (= 0.001 milligram) in 100 grams of substance; that is, parts per million.

Fresh beef	0.7–0.8
Fresh veal	0.5–1
Milk	less than 0.05
White of egg	none
Yolk of egg	0.5
Mackerel	2.7–3.9
Crab, muscle	2.2
" egg and fat	35.7
" shell	104
" whole animal	45.3
Corn	0.7–0.85
Wheat bread	0.71
Cabbage	0.2
String beans	none
Potatoes	1.12
Burgundy wine	0.27
Beer	0.01
Water of the Seine	0.5
Sea water, surface	1.1
" " 10 meters deep	2.5
White salt	0.7
English salt	15
Gray salt	45
Rock salt	14
" " from Stassfurt	2.6

Gautier draws the following conclusions: Muscle contains very little arsenic in comparison with certain organs, and this can be considered as circulating rather than fixed arsenic; great variations are found in the flesh of the same species of animal, in fish unquestionably due to the varying arsenic of the sea and to the food; of man's food, certain fish and crustaceans, and gray salt are richest in arsenic, but in general the chief sources are wine, water and salt; some foods contain no trace of arsenic, so that it can not be held that arsenic is universally present, or that it is a constant constituent of the living cell. From Parisian statistics for ten years, it may be considered that a man ingests 20.9 micrograms of arsenic per day, or 7.66 milligrams per year. In medico-legal cases, it is recommended that only such organs as normally contain arsenic merely in traces, be examined, as the liver, spleen, muscle and washed intestine. If the contents of the intestine show more than one tenth of a milligram of arsenic, we may be sure it did not come from normal food.

J. L. H.

BOTANY AT THE CUBAN EXPERIMENT STATION.

The organization of the botanical work at the Estacion Central Agronomica de Cuba is now far enough advanced to justify a brief account of our facilities and plans for future work. At least three of the departments of the station will be of interest to botanists. The horticultural department is under the charge of Professor C. F. Austin, late of the Maryland Agricultural Experiment Station, with E. W. Halstead, of New Mexico, as assistant. Among the interesting lines of work begun by this department may be mentioned the trial of a large line of temperate fruits, vegetables and ornamentals in order to note their behavior under tropical conditions and to determine which among them can be profitably grown in Cuba. The native Cuban varieties will also be collected and grown for the purpose of comparative studies and to furnish the basis for the selection of improved strains. Attention will be given to the introduction of promising novelties from other tropical countries with a view to building up a living collection of as many as possible of the economic plants that will thrive under the conditions prevailing at this place. This department too will be charged with the care of the living collections of Cuban plants that are of botanical interest only. It is hoped in the course of time to have living specimens of many of the more interesting native plants. An abundance of land is available for these purposes, and propagating sheds, cheese-cloth tents and other appliances are being provided.

The department of vegetable pathology is of course largely botanical, though as here constituted it includes economic entomology. It is in charge of Dr. Mel T. Cook, of Indiana, with Mr. W. T. Horne, of Nebraska, as assistant. The department is provided with a roomy laboratory which is to be shared by the bacteriologist of the animal industry department. It is equipped with the necessary apparatus for rearing and studying disease-producing organisms of all kinds, whether animal or vegetable, including the usual list of glassware, sterilizers, incubators, microtomes and microscopes, besides a complete Zeiss micro-photographic outfit.

The botanical department proper is in charge of Professor C. F. Baker, of Pomona College, California, with Mr. Percy Wilson, of the New York Botanical Garden, as assistant. It is provided with an abundance of room for laboratory and museum purposes. The furnishings include herbarium cases of native hard-woods. The library already contains many of the more important general works, and a special effort is being made to get together as complete a collection as possible of books relating to tropical American botany. The private libraries of Professor Baker and of the writer are also on deposit and are accessible. These include several thousand additional titles. Through the generosity of the New York Botanical Garden and the purchase of Mr. Heller's private collection of West Indian plants, the herbarium already comprises several thousand mounted sheets of West Indian plants that have been determined at the leading herbaria. According to arrangements with Professor Baker, his private herbarium containing over a hundred thousand specimens is deposited at the station and is available for study. This collection is notably rich in tropical American plants containing more or less complete sets of the collections of Sentenis and Heller in Porto Rico; Otto in Trinidad and Cuba; Ehrenberg, Pringle, Schiede, Seler and Purpus in Mexico; Brandegee in Lower California; Baker in Nicaragua; Moritz in Colombia; Schomburgh in Guiana, and Sello in Brazil. Work in collecting the local flora has been actively pushed since the first of July, and much valuable material has already been secured. Plans are being matured for extending this work to other parts of the island in the near future. Particular attention will, of course, be given to all questions connected with economic botany, including forestry problems, study of the native grasses and legumes and of troublesome weeds, and the gathering together for the living collections of native medicinal plants or those yielding fibers, resins, gums or other possible commercial products. At all times, however, the work will be directed towards a

complete botanical survey of the island, since the fact is fully appreciated that the natural plant covering of a region is closely correlated with its agricultural possibilities. As one of the results of this survey it is planned to publish an illustrated flora of Cuba. Work towards that end has already been begun, and it is proposed to prosecute it as rapidly as circumstances will permit. In this connection it will be necessary for the botanist to visit the larger American and European herbaria where types of Cuban plants are likely to be found.

There are, however, numerous smaller collections, both public and private, which contain interesting Cuban material. Where it is possible to secure the loan of such material it will be thankfully received and carefully returned. A large quantity of duplicate material is being collected with which to repay such courtesies and to offer in exchange for other tropical American plants. It will not, however, be the policy of this institution to offer sets of such material for sale.

An available tropical laboratory has long been the dream of American botanists. Within the last few months this dream has been realized by the arrangement between the Jamaican government and the New York Botanical Garden for the use of the Cinchona plantations. It is now possible to offer the use of a second tropical laboratory. We feel that the occasional residence among us of active botanists from other institutions, bringing, as they will, fresh suggestions and inspiration, would be of the greatest benefit to us. We, therefore, freely offer the use of our facilities to any properly accredited botanist who cares to make use of them for any line of botanical investigation, stipulating only that arrangements be made long enough in advance to avoid possible conflicts. Persons desiring to do much microscopic work should bring their own instruments with them. Santiago de las Vegas is situated twelve miles south of Havana in a rolling, open country. There are four trains a day to and from Havana over the Western Railroad. The elevation is only about one hundred and fifty feet. The conditions are, therefore, absolutely different from those in Cinchona with its rugged mountains and five thousand feet of elevation, and a residence at one of them will only sharpen the appetite for experiences at the other.

F. S. EARLE,
Director Cuban Experiment Station.

THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE.

WE hope to print later an account of the work of the International Congress of Arts and Science, held last week at St. Louis, and we have already printed the program and a description of the aims of the congress by Professor Münsterberg, who was chiefly responsible for its plan. In the last issue will be found the address of the president and in this issue the address before the department of physical science; others of the important addresses will appear subsequently. These articles and addresses give an adequate impression of the work of the congress, and only a few words are needed at this time.

It was the unanimous opinion of nearly all those present that the congress was successful and successful beyond the anticipations that had been formed. There has perhaps never been assembled together a group of scholars so notable, and the addresses were real and in some cases important contributions to science. With the possible exception of the 'Encyclopædia Britannica,' the addresses when published together will give the best review that has ever appeared of contemporary science and scholarship. There were about a hundred foreign delegates, each a leader in his science. A selection of names must be almost at random, but it may be questioned whether there were ever before gathered together in one room men of science and scholars so eminent as Poincaré, Darboux, Picard, Boltzmann, Ostwald, van't Hoff, Ramsay, Moissan, Backlund, Arrhenius, Murray, Penck, Zirkel, de Vries, Giard, Delage, Hertwig, Waldeyer, Seler, Höff-

ding, Erdmann, Ward, Liebreich, Kitasato, Semon, Escherlich, Rein, Lamprecht, Conrad, Furwängler, Harnack, Brunialti and Bryce. The American speakers and chairman formed a group of leaders in scientific research, of whom any country might be proud.

A congress of arts and science gives distinction to a universal exposition, but no one supposes that it is the most suitable place for such a meeting. There are many material difficulties which were by no means overcome at St. Louis. The audiences averaged about a hundred—though in one case at least there were only five hearers present—but they were not composed chiefly of scientific men. Criticism should, however, be overshadowed by appreciation. Never before has an attempt been made to give such a complete and unified summary of the progress of science. President Francis, Mr. Rogers, Mr. Schiff and other officers of the exposition deserve thanks and honor for their interest in the congress; President Butler and other members of the administrative board, for the general arrangements, and Professors Newcomb, the president, Münsterberg and Small, the vice-presidents, for the work of organization.

SCIENTIFIC NOTES AND NEWS.

The honorary vice-presidents of the International Congress of Arts and Science were the Hon. James Bryce, Great Britain; M. Gaston Darboux, France; Professor Wilhelm Waldeyer, Germany; Dr. Oskar Backlund, Russia; Professor Theodore Escherich, Austria; Signor Attilio Brunialti, Italy. The executive secretary of the congress was Dr. L. O. Howard, permanent secretary of the American Association for the Advancement of Science.

Captain Scott and the officers and men of the *Discovery* were welcomed at the East India dock by luncheon on their arrival on September 16, the invitations being sent by the presidents of the Royal and the Royal Geographical Societies. In the evening Captain Scott and the officers were entertained at a dinner given by the Royal Geographical Society. Addresses were made by Sir Clements Markham, president of the Royal Geographical Society, Captain Scott and others.

The Medical and Chirurgical Faculty of Maryland has asked Professor William Osler to sit for a portrait to be placed in the hall of the faculty in Baltimore. It is stated that Professor Osler will not sever his connection with the Johns Hopkins University until after the end of the present session.

Dr. Benno Erdmann, professor of philosophy at the University of Bonn, who gave one of the addresses at the St. Louis Congress, celebrated the twenty-fifth anniversary of his professorate on August 29.

Dr. James Ward, professor of moral philosophy and logic, at Cambridge University, gave the annual address before the Philosophical Union of the University of California, on August 26.

Professor Cleveland Abbe, of the U. S. Weather Bureau, delivered an address on 'Instruction and Research by Weather Bureau Officials' at the recent session of the United States Weather Bureau Officials at Peoria.

Dr. Aug. Wassermann, titular professor of internal medicine and bacteriology at the University of Berlin, gave an address on 'The Theory and Practise of Immunity,' before a special meeting of the New York Pathological Society, on September 28.

Dr. Ronald Ross, of the Liverpool School of Tropical Medicine, who is at present in the United States as delegate to the recent Congress of Arts and Science at St. Louis, will proceed to Panama as guest of the Canal Commission.

Professor F. H. Herrick, professor of biology at Western Reserve University, has returned to the United States after a year's absence in Europe.

The British chancelor of the exchequer has appointed the following gentlemen to serve as members of a committee to inquire into the use of duty-free alcohol for industrial pur-

poses: Sir Henry Primrose, K.C.B., C.S.I., chairman; Sir William Crookes, F.R.S.; Sir W. H. Holland, M.P.; the Hon. J. Scott-Montagu, M.P.; Mr. Lothian D. Nicholson; Dr. W. Somerville; Dr. T. E. Thorpe, C.B., F.R.S.; and Mr. Thomas Tyrer.

AMONG those invited to lecture in the annual course of public lectures on 'Contemporary Educational Problems,' given by Teachers College, Columbia University, are Dr. John H. Finley, president of the College of the City of New York; Mr. St. Clair McKelway; Professor Liberty H. Bailey, dean of the College of Agriculture, Cornell University; Dr. Henry M. Leipziger, supervisor of lectures, New York City; Professor Felix Adler; Dr. Walter H. Page, editor of the *World's Work*, and Mr. Wallace H. Buttrick, executive secretary of the General Educational Board.

THE autumn lectures of the New York Botanical Garden will be delivered in the lecture hall of the museum building of the garden, Bronx Park, on Saturday afternoons, at 4:30 o'clock, as follows:

October 1, 'The Origin of Species as illustrated by the Evening Primrose,' by Professor Hugo de Vries.

October 8, 'The Botanical Exploration of the Bahamas,' by Dr. N. L. Britton.

October 15, 'A Summer at the Desert Laboratory,' by Professor Francis E. Lloyd.

October 22, 'Botanizing in the Austrian Tyrol,' by Dr. W. A. Murrill.

October 29, 'Life-History of a Fern,' by Professor L. M. Underwood.

November 5, 'Fossil Plants of the Vicinity of New York,' by Dr. Arthur Hollick.

November 12, 'The Effect of Wounding on Plants,' by Professor H. M. Richards.

November 19, 'Hybrids; Their Nature and Behavior,' by Dr. D. T. MacDougal.

A SERIES of nine lectures on science and travel has been arranged by the Field Columbian Museum at 3 o'clock on Saturday afternoons during October and November. The program is as follows:

October 1, 'Wild Flowers of the Chicago Basin,' Dr. C. F. Millspaugh, curator of botany.

October 8, 'Japan—Land of Lacquer and Bamboo,' Dr. C. F. Millsbaugh, curator of botany.

October 15, 'Variation of Birds,' Dr. N. Dearborn, department of ornithology.

October 22, 'Crystals,' Dr. O. C. Farrington, curator of geology.

October 29, 'Wyandotte and Marengo caves,' Dr. O. C. Farrington, curator of geology.

November 5, 'A Naturalist in Africa—Field Columbian Museum Expedition,' Professor D. G. Elliot, F.R.S.E., curator of zoology.

November 12, 'Cats and the Lands they Inhabit,' Professor D. G. Elliot, F.R.S.E., curator of zoology.

November 19, 'The Decorative Art of the North American Indians'—Part 1, Dr. G. A. Dorsey, curator of anthropology.

November 26, 'The Decorative Art of the North American Indians'—Part 2, Dr. G. A. Dorsey, curator of anthropology.

AT a business meeting of the Elisha Mitchell Society of the University of North Carolina, held on September 12, the following officers were elected:

President—Professor Wm. Cain.
Vice-President—Professor J. E. Mills.
Corresponding Secretary—President F. P. Venable.
Recording Secretary—Professor A. S. Wheeler.
Editorial Committee—Professor W. C. Coker, Professor J. E. Latta, Professor A. Henderson.

PROFESSOR NILS FINSSEN, of Copenhagen, known for his discovery of the light cure for lupus, died on September 24.

KARL FREIHERR V. ERLANGER, the African explorer, has died at the age of thirty-two years.

IN a recent address before the Royal Geographical Society of London, the president, Sir Clements Markham, stated that the work of the society had so greatly increased that it would be necessary to move into a larger building. A good sum had been offered for the present house, but in addition to that sum a far larger amount would be required to obtain a freehold site and erect a suitable building. Several sites had been offered, but the council did not feel justified in taking further steps until most of the amount required (about $600,000) had been subscribed. In the meantime a special committee is considering the question of increasing the accommodations.

CABLEGRAMS to the daily papers report an eruption of Mt. Vesuvius more violent than any since 1872. The upper station of the fu-

nicular railway has been destroyed and the metal of the tracks has been melted.

The *British Medical Journal* states that an examination by Professor Dunstan at the Imperial Institute, London, of certain minerals discovered during the recent mineralogical survey of Ceylon has shown that the principal constituent of one found in refuse from gem washings near Belangoda is radio-active; it contains 75 per cent. of thorium oxide, and it is thought probable that radium is present.

Professor James Beart Simonds, of the Isle of Wight, has bequeathed his veterinary specimens and library of veterinary and scientific works to the Royal Veterinary College, London.

It is reported that Dr. Theodore Koch, of the Berlin Museum für Völkerkunde, who is exploring the districts of the Upper Amazon, reports that he has advanced farther than any white man on the Rio Tiqui, and has come into contact with hitherto unknown Indian tribes. He spent several weeks in their villages, and has brought back from his journey a rich collection of photographs and native articles, among others the famous signal drum of the Tukano tribe. He hopes to prolong his operations till the spring of next year, but the continued disputes between the Peruvians and Brazilians have somewhat interfered with his arrangements.

UNIVERSITY AND EDUCATIONAL NEWS.

The late Professor Daniel Willard Fiske has bequeathed the main part of his estate to Cornell University. It is said that the bequest amounts to between $500,000 to $1,000,000. It will be remembered that Professor Fiske's wife, who died some two years ago, left $2,000,000 to Cornell University, but that the will was broken by Professor Fiske.

The main building of the University of Minnesota was destroyed by fire on September 24, entailing a loss of $125,000 which is said to be covered by insurance.

Sir Alfred Jones has given £500 and Mr. John Holt £200 to the Liverpool School of Tropical Medicine for a fund to be known as the Sir William MacGregor Fund, in honor of the newly appointed governor of Newfoundland.

The presidency of Tulane University has been offered to Dr. E. B. Copeland, president of the Missouri State Normal School, Warrensburg, Mo.

Dr. Adolf Meyer, of the N. Y. State Pathological Institute, has been appointed professor of psychiatry in the Cornell University Medical School in the place of Dr. Allan McLane Hamilton, who recently resigned.

The lectureship of pathological chemistry, at New York University, recently endowed by Dr. C. A. Herter, will be held during the present year by Dr. P. A. Levene, of the N. Y. State Pathological Institute.

The following appointments have been made at Lehigh University: Winter L. Wilson, C.E., M.S., Lehigh, '88, and recently professor of civil engineering in Tulane University, assistant professor in civil engineering; Sherman M. Turrill, C.E., Cornell, '91, and Robert W. Gay, B.S., C.E., New York University, instructors in civil engineering; Arthur W. Klein, M.E., Lehigh, '99, and Evert O. Eastwood, A.M., B.S., University of Virginia, and Massachusetts Institute of Technology, instructors in civil engineering. Other new instructors are Charles W. Brown, A.M., Brown University and Harvard, in the department of geology; Stanley S. Seyfert, E. E. Lehigh, '04, electrical engineering; George C. Beck, A.C., Lehigh, '04, assistant in chemistry.

Lorande Loss Woodruff, A.M. (Columbia), has been advanced to an instructorship in biology at Williams College.

At Dartmouth College, the following appointments have been made: *Mathematics*, C. A. Holden, assistant professor; Mr. Barton, instructor; *Biology*, Mr. Lyman, instructor in biology (botany), made assistant professor; *Medical School*, Dr. Percy Bartlett, A.B., Bowdoin, '92, M.D., Dartmouth, '00, instructor in anatomy; Dr. C. C. Stewart, assistant professor of physiology, Pennsylvania, assistant professor of physiology.

Dr. Hermann Kossel, of the Imperial Board of Health at Berlin, has been called to the chair of hygiene at the University of Giessen, as the successor of Dr. Georg Gaffky.

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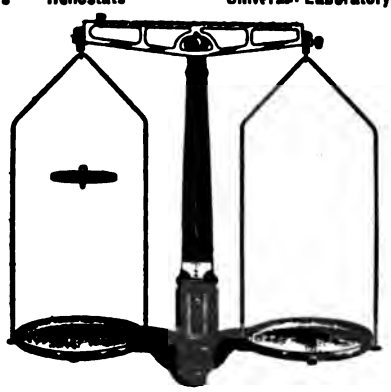

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THE SCIENCES OF THE IDEAL.*

I SHALL not attempt, in this address, either to justify or to criticize the name, normative science, under which the doctrines which constitute this division are grouped. It is enough for my purpose to recognize at the outset that I am required, by the plans of this congress, to explain what scientific interests seem to me to be common to the work of the philosophers and of the mathematicians. The task is one which makes severe demands upon the indulgence of the listener, and upon the expository powers of the speaker, but it is a task for which the present age has well prepared the way. The spirit which Descartes and Leibniz illustrated seems likely soon to become, in a new and higher sense, prominent in science. The mathematicians are becoming more and more philosophical. The philosophers, in the near future, will become, I believe, more and more mathematical. It is my office to indicate, as well as the brief time and my poor powers may permit, why this ought to be so.

To this end I shall first point out what is that most general community of interest which unites all the sciences that belong to our division. Then I shall indicate what type of recent and special scientific work most obviously bears upon the tasks of all of us alike. Thirdly, I shall state some results and problems to which this type of scientific work has given rise, and shall try to show what promise we have of an early increase of insight regarding our common interests.

I.

The most general community of interest which unites the various scientific activities

* Address for the St. Louis Congress of Arts and Science, before the Division of Normative Science.

that belong to our division is this: We are all concerned with what may be called ideal truth, as distinct from physical truth. Some of us also have a strong interest in physical truth; but none of us lack a notable and scientific concern for the realm of ideas, viewed as ideas.

Let me explain what I mean by these terms. Whoever studies physical truth (taking that term in its most general sense) seeks to observe, to collate and, in the end, to control, facts which he regards as external to his own thought. But instead of thus looking mainly without, it is possible for a man chiefly to take account, let us say, of the consequences of his own hypothetical assumptions—assumptions which may possess but a very remote relation to the physical world. Or again, it is possible for such a student to be mainly devoted to reflecting upon the formal validity of his own inferences, or upon the meaning of his own presuppositions, or upon the value and the interrelation of human ideals. Any such scientific work, reflective, considerate principally of the thinker's own constructions and purposes, or of the constructions and purposes of humanity in general, is a pursuit of ideal truth. The searcher who is mainly devoted to the inquiry into what he regards as external facts, is indeed active; but his activity is molded by an order of existence which he conceives as complete apart from his activity. He is thoughtful; but a power not himself assigns to him the problems about which he thinks. He is guided by ideals; but his principal ideal takes the form of an acceptance of the world as it is, independently of his ideals. His dealings are with nature. His aim is the conquest of a foreign realm. But the student of what may be called, in general terms, ideal truth, while he is devoted as his fellow, the observer of outer nature, to the general purpose of being faithful to the verity as he finds it, is still aware that his own way of finding, or his own creative activity as an inventor of hypotheses, or his own powers of inference, or his conscious ideals, constitute in the main the object into which he is inquiring, and so form an essential aspect of the sort of verity which he is endeavoring to discover. The guide, then, of such a student is, in a peculiar sense, his own reason. His goal is the comprehension of his own meaning, the conscious and thoughtful conquest of himself. His great enemy is not the mystery of outer nature, but the imperfection of his reflective powers. He is, indeed, as unwilling as is any scientific worker to trust his private caprices. He feels as little as does the observer of outer facts, that he is merely noting down, as they pass, the chance products of his arbitrary fantasy. For him, as for any scientific student, truth is indeed objective; and the standards to which he conforms are eternal. But his method is that of an inner considerateness rather than of a curiosity about external phenomena. His objective world is at the same time an essentially ideal world, and the eternal verity in whose light he seeks to live has, throughout his undertakings, a peculiarly intimate relation to the purposes of his own constructive will.

One may then sum up the difference of attitude which is here in question by saying that, while the student of outer nature is explicitly conforming his plans of action, his ideas, his ideals, to an order of truth which he takes to be foreign to himself—the student of the other sort of truth, here especially in question, is attempting to understand his own plans of action, that is, to develop his ideas, or to define his ideals, or else to do both these things.

Now it is not hard to see that this search for some sort of ideal truth is indeed characteristic of every one of the investigations which have been grouped together in our division of the normative sciences. Pure

mathematics shares in common with philosophy this type of scientific interest in ideal, as distinct from physical or phenomenal truth. There is, to be sure, a marked contrast between the ways in which the mathematician and the philosopher approach, select and elaborate their respective sorts of problems. But there is also a close relation between the two types of investigation in question. Let us next consider both the contrast and the analogy in some of their other most general features.

Pure mathematics is concerned with the investigation of the logical consequences of certain exactly statable postulates or hypotheses—such, for instance, as the postulates upon which arithmetic and analysis are founded, or such as the postulates that lie at the basis of any type of geometry. For the pure mathematician, the truth of these hypotheses or postulates depends, not upon the fact that physical nature contains phenomena answering to the postulates, but solely upon the fact that the mathematician is able, with rational consistency, to state these assumed first principles, and to develop their consequences. Dedekind, in his famous essay, 'Was Sind und Was Sollen die Zahlen,' called the whole numbers 'freie Schöpfungen des Menschlichen Geistes'; and, in fact, we need not enter into any discussion of the psychology of our number concept in order to be able to assert that, however we men first came by our conception of the whole numbers, for the mathematician the theory of numerical truth must appear simply as the logical development of the consequences of a few fundamental first principles, such as those which Dedekind himself, or Peano, or other recent writers upon this topic, have, in various forms, stated. A similar formal freedom marks the development of any other theory in the realm of pure mathematics. Pure geometry, from the modern point of view, is neither a doctrine forced upon the human mind by the constitution of any primal form of intuition, nor yet a branch of physical science, limited to describing the spatial arrangement of phenomena in the external world. Pure geometry is the theory of the consequences of certain postulates which the geometer is at liberty consistently to make; so that there are as many types of geometry as there are consistent systems of postulates of that generic type of which the geometer takes account. As is also now well known, it has long been impossible to define pure mathematics as the science of quantity, or to limit the range of the exactly statable hypotheses or postulates with which the mathematician deals to the world of those objects which, ideally speaking, can be viewed as measurable. For the ideally defined measurable objects are by no means the only ones whose properties can be stated in the form of exact postulates or hypotheses; and the possible range of pure mathematics, if taken in the abstract, and viewed apart from any question as to the value of given lines of research, appears to be identical with the whole realm of the consequences of exactly statable ideal hypotheses of every type.

One limitation must, however, be mentioned, to which the assertion just made is, in practise, obviously subject. And this is, indeed, a momentous limitation. The exactly stated ideal hypotheses whose consequences the mathematician develops must possess, as is sometimes said, sufficient intrinsic importance to be worthy of scientific treatment. They must not be trivial hypotheses. The mathematician is not, like the solver of chess problems, merely displaying his skill in dealing with the arbitrary fictions of an ideal game. His truth is, indeed, ideal; his world is, indeed, treated by his science as if this world were the creation of his postulates a 'freie Schöpfung.' But he does not thus create for

mere sport. On the contrary, he reports a significant order of truth. As a fact, the ideal systems of the pure mathematician are customarily defined with an obvious, even though often highly abstract and remote, relation to the structure of our ordinary empirical world. Thus the various algebras which have been actually developed have, in the main, definite relations to the structure of the space world of our physical experience. The different systems of ideal geometry, even in all their ideality, still cluster, so to speak, about the suggestions which our daily experience of space and of matter give us. Yet I suppose that no mathematician would be disposed, at the present time, to accept any brief definition of the degree of closeness or remoteness of relation to ordinary experience which shall serve to distinguish a trivial from a genuinely significant branch of mathematical theory. In general a mathematician who is devoted to the theory of functions, or to group theory, appears to spend little time in attempting to show why the development of the consequences of his postulates is a significant enterprise. The concrete mathematical interest of his inquiry sustains him in his labors, and wins for him the sympathy of his fellows. To the questions, 'Why consider the ideal structure of just this system of object at all?' 'Why study various sorts of numbers, or the properties of functions, or of groups, or the system of points in projective geometry?' —the pure mathematician in general, cares to reply only, that the topic of his special investigation appears to him to possess sufficient mathematical interest. The freedom of his science thus justifies his enterprise. Yet, as I just pointed out, this freedom is never mere caprice. This ideal interest is not without a general relation to the concerns even of common sense. In brief, as it seems at once fair to say, the pure mathematician is working under the influence of more or less clearly conscious philosophical motives. He does not usually attempt to define what distinguishes a significant from a trivial system of postulates, or what constitutes a problem worth attacking from the point of view of pure mathematics. But he practically recognizes such a distinction between the trivial and the significant regions of the world of ideal truth, and since philosophy is concerned with the significance of ideas, this recognition brings the mathematician near in spirit to the philosopher.

Such, then, is the position of the pure mathematician. What, by way of contrast, is that of the philosopher? We may reply that to state the formal consequences of exact assumptions is one thing; to reflect upon the mutual relations, and the whole significance of such assumptions, does indeed involve other interests; and these other interests are the ones which directly carry us over to the realm of philosophy. If the theory of numbers belongs to pure mathematics, the study of the place of the number concept in the system of human ideas belongs to philosophy. Like the mathematician, the philosopher deals directly with a realm of ideal truth. But to unify our knowledge, to comprehend its sources, its meaning, and its relations to the whole of human life, these aims constitute the proper goal of the philosopher. In order, however, to accomplish his aims, the philosopher must, indeed, take account of the results of the special physical science; but he must also turn from the world of outer phenomena to an ideal world. For the unity of things is never, for us mortals, anything that we find given in our experience. You can not see the unity of knowledge; you can not describe it as a phenomenon. It is for us now, an ideal. And precisely so, the meaning of things, the relation of knowledge to life, the significance of our ideals, their bearing upon one

another—these are never, for us men, phenomenally present data. Hence the philosopher, however much he ought, as indeed he ought, to take account of phenomena, and of the results of the special physical sciences, is quite as deeply interested in his own way, as the mathematician is interested in his way, in the consideration of an ideal realm. Only, unlike the mathematician, the philosopher does not first abstract from the empirical suggestions upon which his exact ideas are actually based, and then content himself merely with developing the logical consequences of these ideas. On the contrary, his main interest is not in any idea or fact in so far as it is viewed by itself, but rather in the interrelations, in the common significance, in the unity, of all fundamental ideas, and in their relations both to the phenomenal facts and to life! On the whole, he, therefore, neither consents, like the student of a special science of experience, to seek his freedom solely through conformity to the phenomena which are to be described; nor is he content, like the pure mathematician, to win his truth solely through the exact definition of the formal consequences of his freely defined hypotheses. He is making an effort to discover the sense and the unity of the business of his own life.

It is no part of my purpose to attempt to show here how this general philosophical interest differentiates into the various interests of metaphysics, of the philosophy of religion, of ethics, of esthetics, of logic. Enough—I have tried to illustrate how, while both the philosopher and the mathematician have an interest in the meaning of ideas rather than in the description of external facts, still there is a contrast which does, indeed, keep their work in large measure asunder, viz., the contrast due to the fact that the mathematician is directly concerned with developing the consequences of certain freely assumed systems of postulates or hypotheses; while the philosopher is interested in the significance, in the unity and in the relation to life, of all the fundamental ideals and postulates of the human mind.

Yet not even thus do we sufficiently state how closely related the two tasks are. For this very contrast, as we have also suggested, is, even within its own limits, no final or perfectly sharp contrast. There is a deep analogy between the two tasks. For the mathematician, as we have just seen, is not evenly interested in developing the consequences of any and every system of freely assumed postulates. He is no mere solver of arbitrary ideal puzzles in general. His systems of postulates are so chosen as to be not trivial, but significant. They are, therefore, in fact, but abstractly defined aspects of the very system of eternal truth whose expression is the universe. In this sense the mathematician is as genuinely interested as is the philosopher in the significant use of his scientific freedom. On the other hand, the philosopher, in reflecting upon the significance and the unity of fundamental ideas, can only do so with success in case he makes due inquiry into the logical consequences of given ideas. And this he can accomplish only if, upon occasion, he employs the exact methods of the mathematician, and develops his systems of ideal truth with the precision of which only mathematical research is capable. As a fact, then, the mathematician and the philosopher deal with ideal truth in ways which are not only contrasted, but profoundly interconnected. The mathematician, in so far as he consciously distinguishes significant from trivial problems, and ideal systems, is a philosopher. The philosopher, in so far as he seeks exactness of logical method, in his reflection, must meanwhile aim to be, within his own limits, a mathematician. He, indeed, will not in future, like Spinoza,

seek to reduce philosophy to the mere development, in mathematical form, of the consequences of certain arbitrary hypotheses. He will distinguish between a reflection upon the unity of the system of truth and an abstract development of this or that selected aspect of the system. But he will see more and more that, in so far as he undertakes to be exact, he must aim to become, in his own way, and with due regard to his own purposes, mathematical; and thus the union of mathematical and philosophical inquiries, in the future, will tend to become closer and closer.

II.

So far, then, I have dwelt upon extremely general considerations relating to the unity and the contrast of mathematical and philosophical inquiries. I can well conceive, however, that the individual worker in any one of the numerous branches of investigation which are represented by the body of students whom I am privileged to address, may at this point mentally interpose the objection that all these considerations are, indeed, far too general to be of practical interest to any of us. Of course, all we who study these so-called normative sciences are, indeed, interested in ideas, for their own sakes—in ideas so distinct from, although of course also somehow related to, phenomena. Of course some of us are rather devoted to the development of the consequences of exactly stated ideal hypotheses, and others to reflecting as we can upon what certain ideas and ideals are good for, and upon what the unity is of all ideas and ideals. Of course if we are wise enough to do so, we have much to learn from one another. But, you will say, the assertion of all these things is a commonplace. The expression of the desire for further mutual cooperation is a pious wish. You will insist upon asking further: "Is there just now any concrete instance in a modern type of research which furnishes results such as are of interest to all of us? Are we actually doing any productive work in common? Are the philosophers contributing anything to human knowledge which has a genuine bearing upon the interests of mathematical science? Are the mathematicians contributing anything to philosophy?"

These questions are perfectly fair. Moreover, as it happens, they can be distinctly answered in the affirmative. The present age is one of a rapid advance in the actual unification of the fields of investigation which are included within the scope of this present division. What little time remains to me must be devoted to indicating, as well as I can, in what sense this is true. I shall have still to deal in very broad generalities. I shall try to make these generalities definite enough to be not wholly unfruitful.

We have already emphasized one question which may be said to interest, in a very direct way, both the mathematician and the philosopher. The ideal postulates, whose consequences mathematical science undertakes to develop, must be, we have said, significant postulates, involving ideas whose exact definition and exposition repay the labor of scientific scrutiny. Number, space, continuity, functional correspondence or dependence, group-structure—these are examples of such significant ideas; the postulates or ideal assumptions upon which the theory of such ideas depends are significant postulates, and are not the mere conventions of an arbitrary game. But now what constitutes the significance of an idea, or of an abstract mathematical theory? What gives an idea a worthy place in the whole scheme of human ideas? Is it the possibility of finding a physical application for a mathematical theory which for us decides what is the value of the theory? No, the theory of functions, the theory of numbers, group theory, have

a significance which no mathematician would consent to measure in terms of the present applicability or non-applicability of these theories in physical science? In vain, then, does one attempt to use the test of applied mathematics as the main criticism of the value of a theory of pure mathematics. The value of an idea, for the sciences which constitute our division, is dependent upon the place which this idea occupies in the whole organized scheme or system of human ideas. The idea of number, for instance, familiar as its applications are, does not derive its main value from the fact that eggs and dollars and star-clusters can be counted, but rather from the fact that the idea of numbers has those relations to other fundamental ideas which recent logical theory has made prominent—relations, for instance, to the concept of order, to the theory of classes or collections of objects viewed in general, and to the metaphysical concept of the self. Relations of this sort, which the discussions of the number concept by Dedekind, Cantor, Peano and Russell have recently brought to light—such relations, I say, constitute what truly justified Gauss in calling the theory of numbers a 'divine science.' As against such deeper relations, the countless applications of the number concept in ordinary life, and in science, are, from the truly philosophical point of view, of comparatively small moment. What we want, in the work of our division of the sciences, is to bring to light the unity of truth, either, as in mathematics, by developing systems of truth which are significant by virtue of their actual relations to this unity, or, as in philosophy, by explicitly seeking the central idea about which all the many ideas cluster.

Now, an ancient and fundamental problem for the philosophers is that which has been called the problem of the categories. This problem of the categories is simply the more formal aspect of the whole philosophical problem just defined. The philosopher aims to comprehend the unity of the system of human ideas and ideals. Well, then, what are the primal ideas? Upon what group of concepts do the other concepts of human science logically depend? About what central interests is the system of human ideals clustered? In ancient thought Aristotle already approached this problem in one way. Kant, in the eighteenth century, dealt with it in another. We students of philosophy are accustomed to regret what we call the excessive formalism of Kant, to lament that Kant was so much the slave of his own relatively superficial and accidental table of categories, and that he made the treatment of every sort of philosophical problem turn upon his own schematism. Yet we can not doubt that Kant was right in maintaining that philosophy needs, for the successful development of every one of its departments, a well-devised and substantially complete system of categories. Our objection to Kant's over-confidence in the virtues of his own schematism is due to the fact that we do not now accept his table of categories as an adequate view of the fundamental concepts. The efforts of philosophers since Kant have been repeatedly devoted to the task of replacing his scheme of categories by a more adequate one. I am far from regarding these purely philosophical efforts made since Kant as fruitless, but they have remained, so far, very incomplete, and they have been held back from their due fulness of success by the lack of a sufficiently careful survey and analysis of the processes of thought as these have come to be embodied in the living sciences. Such concepts as number, quantity, space, time, cause, continuity, have been dealt with by the pure philosophers far too summarily and superficially. A more thoroughgoing analysis has been needed.

But now, in comparatively recent times, there has developed a region of inquiry which one may call by the general name of modern logic. To the constitution of this new region of inquiry men have principally contributed who began as mathematicians, but who, in the course of their work, have been led to become more and more philosophers. Of late, however, various philosophers, who were originally in no sense mathematicians, becoming aware of the importance of the new type of research, are in their turn attempting both to assimilate and to supplement the undertakings which were begun from the mathematical side. As a result, the logical problem of the categories has to-day become almost equally a problem for the logicians of mathematics and for those students of philosophy who take any serious interest in exactness of method in their own branch of work. The result of this actual cooperation of men from both sides is that, as I think, we are to-day, for the first time, in sight of what is still, as I freely admit, a somewhat distant goal, viz., the relatively complete rational analysis and tabulation of the fundamental categories of human thought. That the student of ethics is as much interested in such an investigation as is the metaphysician, that the philosopher of religion needs a well-completed table of categories quite as much as does the pure logician, every competent student of such topics ought to admit. And that the enterprise in question keenly interests the mathematicians is shown by the prominent part which some of them have taken in the researches in question. Here, then, is the type of recent scientific work whose results most obviously bear upon the tasks of all of us alike.

A catalogue of the names of the workers in this wide field of modern logic would be out of place here. Yet one must, indeed, indicate what lines of research are especially in question. From the purely mathematical side, the investigations of the type to which I now refer may be viewed (somewhat arbitrarily) as beginning with that famous examination into one of the postulates of Euclid's geometry which gave rise to the so-called non-Euclidean geometry. The question here originally at issue was one of a comparatively limited scope, viz., the question whether Euclid's parallel-line postulate was a logical consequence of the other geometrical principles. But the investigation rapidly develops into a general study of the foundations of geometry—a study to which contributions are still almost constantly appearing. Somewhat independently of this line of inquiry there grew up, during the latter half of the nineteenth century, that reexamination of the bases of arithmetic and analysis which is associated with the names of Dedekind, Weierstrass and George Cantor. At the present time, the labors of a number of other inquirers (amongst whom we may mention the school of Peano and Pieri in Italy, and men such as Poincaré and Couturat in France, Hilbert in Germany, Bertram Russell and Whitehead in England and an energetic group of our American mathematicians—men such as Professor Moore, Professor Halsted, Dr. Huntington, Dr. Veblen and a considerable number of others) have been added to the earlier researches. The result is that we have recently come for the first time to be able to see, with some completeness, what the assumed first principles of pure mathematics actually are. As was to be expected, these principles are capable of more than one formulation, according as they are approached from one side or from another. As was also to be expected, the entire edifice of pure mathematics, so far as it has yet been erected, actually rests upon a very few fundamental concepts and postulates, however you may formulate them. What was not observed,

however, by the earlier, and especially by the philosophical, students of the categories, is the form which these postulates tend to assume when they are rigidly analyzed.

This form depends upon the precise definition and classification of certain types of relations. The whole of geometry, for instance, including metrical geometry, can be developed from a set of postulates which demand the existence of points that stand in certain ordinal relationships. The ordinal relationships can be reduced, according as the series of points considered is open or closed, either to the well-known relationship in which three points stand when one is between the other two upon a right line, or else to the ordinal relationship in which four points stand when they are separated by pairs; and these two ordinal relationships, by means of various logical devices, can be regarded as variations of a single fundamental form. Cayley and Klein founded the logical theory of geometry here in question. Russell, and in another way Dr. Veblen, have given it its most recent expressions. In the same way, the theory of whole numbers can be reduced to sets of principles which demand the existence of certain ideal objects in certain simple ordinal relations. Dedekind and Peano have worked out such ordinal theories of the number concept. In another development of the theory of the cardinal whole numbers, which Russell and Whitehead have worked out, ordinal concepts are introduced only secondarily, and the theory depends upon the fundamental relation of the equivalence or non-equivalence of collections of objects. But here also a certain simple type of relation determines the definitions and the development of the whole theory.

Two results follow from such a fashion of logically analyzing the first principles of mathematical science. In the first place, as just pointed out, we learn *how few and simple are the conceptions and postulates* upon which the actual edifice of exact science rests. Pure mathematics, we have said, is free to assume what it chooses. Yet the assumptions whose presence as the foundation principles of the actually existent pure mathematics an exhaustive examination thus reveals, show by their fewness that the ideal freedom of the mathematician to assume and to construct what he pleases, is indeed, in practise, a very decidedly limited freedom. The limitation is, as we have already seen, a limitation which has to do with the essential significance of the fundamental concepts in question. And so the result of this analysis of the bases of the actually developed and significant branches of mathematics, constitutes a sort of empirical revelation of what categories the exact sciences have practically found to be of such significance as to be worthy of exhaustive treatment. Thus the instinctive sense for significant truth which has all along been guiding the development of mathematics, comes at least to a clear and philosophical consciousness. And meanwhile the essential categories of thought are seen in a new light.

The second result still more directly concerns a philosophical logic. It is this: Since the few types of relations which this sort of analysis reveals as the fundamental ones in exact science are of such importance, the logic of the present day is especially required to face the questions: *What is the nature of our concept of relations?* What are the various possible types of relations? Upon what does the variety of these types depend? What unity lies beneath the variety?

As a fact, logic, in its modern forms, viz., first that symbolic logic which Boole first formulated, which Mr. Charles S. Peirce and his pupils have in this country already so highly developed, and which Schroeder in Germany, Peano's school in Italy and

a number of recent English writers, have so effectively furthered—and secondly, the logic of scientific method, which is now so actively pursued, in France, in Germany and in the English-speaking countries—this whole movement in modern logic, as I hold, is rapidly approaching *new solutions of the problem of the fundamental nature and the logic of relations.* The problem is one in which we are all equally interested. To De Morgan in England, in an earlier generation, and, in our time, to Charles Peirce in this country, very important stages in the growth of these problems are due. Russell, in his work on the 'Principles of Mathematics,' has very lately undertaken to sum up the results of the logic of relations, as thus far developed, and to add his own interpretations. Yet I think that Russell has failed to get as near to the foundations of the theory of relations as the present state of the discussion permits. For Russell has failed to take account of what I hold to be the most fundamentally important generalization yet reached in the general theory of relations. This is the generalization set forth as early as 1890, by Mr. A. B. Kempe, of London, in a pair of wonderful, but too much neglected, papers, entitled, respectively, 'The Theory of Mathematical Form,' and 'The Analogy between the Logical Theory of Classes and the Geometrical Theory of Points.' A mere hint first as to the more precise formulation of the problem at issue, and then later as to Kempe's special contribution to that problem, may be in order here, despite the impossibility of any adequate statement.

III.

The two most obviously and universally important kinds of relations known to the exact sciences, as these sciences at present exist, are: (1) The relations of the type of equality or equivalence; and (2) the relations of the type of before and after, or greater and less. The first of these two classes of relations, viz., the class represented, although by no means exhausted, by the various relations actually called, in different branches of science by the one name equality, this class I say, might well be named, as I myself have proposed, the leveling relations. A collection of objects between any two of which some one relation of this type holds, may be said to be a collection whose members, in some defined sense or other, are on the same level. The second of these two classes of relations, viz., those of the type of before and after, or greater and less—this class of relations, I say, consists of what are nowadays often called the serial relations. And a collection of objects such that, if any pair of these objects be chosen, a determinate one of this pair stands to the other one of the same pair in some determinate relation of this second type, and in a relation which remains constant for all the pairs that can be thus formed out of the members of this collection—any such collection, I say, constitutes a one-dimensional open series. Thus, in case of a file of men, if you choose any pair of men belonging to the file, a determinate one of them is, in the file, before the other. In the number series, of any two numbers, a determinate one is greater than the other. Wherever such a state of affairs exists, one has a series.

Now these two classes of relations, the leveling relations and the serial relations, agree with one another, and differ from one another in very momentous ways. They *agree* with one another in that both the leveling and the serial relations are what is technically called *transitive;* that is, both classes conform to what Professor James has called the law of 'skipped intermediaries.' Thus, if A is equal to B, and B is equal to C, it follows that A is equal to C. If A is before B, and B is before C, then A is before C. And this property,

which enables you in your reasonings about these relations to skip middle terms, and so to perform some operation of elimination, is the property which is meant when one calls relations of this type transitive. But, on the other hand, these two classes of relations *differ* from each other in that the leveling relations are, while the serial relations are not, *symmetrical* or reciprocal. Thus, if A is equal to B, B is equal to A. But if X is greater than Y, then Y is not greater than X, but less than X. So the leveling relations are symmetrical transitive relations. But the serial relations are transitive relations which are not symmetrical.

All this is now well known. It is notable, however, that nearly all the processes of our exact sciences, as at present developed, can be said to be essentially such as lead either to the placing of sets or classes of objects on the same level, by means of the use of symmetrical transitive relations, or else to the arranging of objects in orderly rows or series, by means of the use of transitive relations which are not symmetrical. This holds also of all the applications of the exact sciences. Whatever else you do in science (or, for that matter, in art), you always lead, in the end, either to the arranging of objects, or of ideas, or of acts, or of movements, in rows or series, or else to the placing of objects or ideas of some sort on the same level, by virtue of some equivalence, or of some invariant character. Thus numbers, functions, lines in geometry, give you examples of serial relations. Equations in mathematics are classic instances of leveling relations. So, of course, are invariants. Thus, again, the whole modern theory of energy consists of two parts, one of which has to do with levels of energy, in so far as the quantity of energy of a closed system remains invariant through all the transformations of the system, while the other part has to do with the irreversible serial order of the transformations of energy themselves, which follow a set of unsymmetrical relations, in so far as energy tends to fall from higher to lower levels of intensity within the same system.

The entire conceivable universe then, and all of our present exact science, can be viewed, if you choose, as a collection of objects or of ideas that, whatever other types of relations may exist, are at least largely characterized either by the leveling relations, or by the serial relations, or by complexes of both sorts of relations. Here, then, we are plainly dealing with very fundamental categories. The 'between' relations of geometry can of course be defined, if you choose, in terms of transitive relations that are not symmetrical. There are, to be sure, some other relations present in exact science, but the two types, the serial and leveling relations, are especially notable.

So far the modern logicians have for some time been in substantial agreement. Russell's brilliant book is a development of the logic of mathematics very largely in terms of the two types of relations which, in my own way, I have just characterized; although Russell gives due regard, of course, to certain other types of relations.

But hereupon the question arises, 'Are these two types of relations what Russell holds them to be, viz., ultimate and irreducible logical facts, unanalyzable categories—mere data for the thinker? Or can we reduce them still further, and thus simplify yet again our view of the categories?

Here is where Kempe's generalization begins to come into sight. These two categories, in at least one very fundamental realm of exact thought, can be reduced to one. There is, namely, a world of ideal objects which especially interest the logician. It is the world of a *totality of pos-*

sible logical classes, or again, it is the ideal world, equivalent in formal structure to the foregoing, but composed of a *totality of possible statements,* or thirdly, it is the world, equivalent once more, in formal structure, to the foregoing, but consisting of a *totality of possible acts of will,* of possible decisions. When we proceed to consider the relational structure of such a world, taken merely in the abstract as such a structure, a relation comes into sight which at once appears to be peculiarly general in its nature. It is the so-called illative relation, the relation which obtains between two classes when one is subsumed under the other, or between two statements, or two decisions, when one implies or entails the other. This relation is transitive, but may be either symmetrical or not symmetrical; so that, according as it is symmetrical or not, it may be used either to establish levels or to generate series. In the order system of the logician's world, the relational structure is thus, in any case, a highly general and fundamental one.

But this is not all. In this the logician's world of classes, or of statements, or of decisions, there is also another relation observable. This is the relation of exclusion or mutual opposition. This is a purely symmetrical or reciprocal relation. It has two forms—obverse or contradictory opposition, *i. e.,* negation proper, and contrary opposition. But both these forms are purely symmetrical. And by proper devices each of them can be stated in terms of the other, or reduced to the other. And further, as Kempe incidentally shows, and as Mrs. Ladd Franklin has also substantially shown in her important theory of the syllogism, *it is possible to state every proposition, or complex of propositions involving the illative relation, in terms of this purely symmetrical relation of opposition.* Hence, so far as mere relational form is concerned, the illative relation itself may be wholly reduced to the symmetrical relation of opposition. This is our first result as to the relational structure of the realm of pure logic, *i. e.,* the realm of classes, of statements, or of decisions.

It follows that, in describing the logician's world of possible classes or of possible decisions, *all unsymmetrical, and so all serial, relations can be stated solely in terms of symmetrical relations, and can be entirely reduced to such relations.* Moreover, as Kempe has also very prettily shown, the relation of opposition, in its two forms, just mentioned, need not be interpreted as obtaining merely between pairs of objects. It may and does obtain between triads, tetrads, *n*-ads of logical entities; and so all that is true of the relations of logical classes may consequently be stated merely by ascribing certain perfectly symmetrical and homogeneous predicates to pairs, triads, tetrads, *n*-ads of logical objects. The essential contrast between symmetrical and unsymmetrical relations thus, in this ideal realm of the logician, simply vanishes. The categories of the logician's world of classes, of statements, or of decisions, are marvelously simple. All the relations present may be viewed as variations of the mere conception of opposition as distinct from non-opposition.

All this holds, of course, so far, merely for the logician's world of classes or of decisions. There, at least, all serial order can actually be derived from wholly symmetrical relations. But Kempe now very beautifully shows (and here lies his great and original contribution to our topic)—he shows, I say, that the ordinal relations of geometry, as well as of the number-system, can all be regarded as indistinguishable from *mere variations of those relations which, in pure logic, one finds to be the symmetrical relations obtaining within pairs or triads of classes or of statements.*

The formal identity of the geometrical relation called 'between' with a purely logical relation which one can define as existing or as not existing amongst the members of a given triad of logical classes, or of logical statements, is shown by Kempe in a fashion that I can not here attempt to expound. But Kempe's result thus enables one, as I believe, to simplify the theory of relations far beyond the point which Russell, in his brilliant book has reached. For Kempe's triadic relation in question can be stated, in what he calls its obverse form, in perfectly symmetrical terms. And he proves very exactly that the resulting logical relation is precisely identical, in all its properties, with the fundamental ordinal relation of geometry.

Thus the order-systems of geometry and analysis appear simply as special cases of the more general order-system of pure logic. The whole, both of analysis and of geometry, can be regarded as a description of certain selected groups of entities, which are chosen, according to special rules, from a single ideal world. This general and inclusive ideal world consists simply of *all the objects which can stand to one another in those symmetrical relations wherein the pure logician finds various statements, or various decisions inevitably standing,* 'Let me,' says in substance Kempe, 'choose from the logician's ideal world of classes or decisions, what entities I will; and I will show you a collection of objects that are in their relational structure, precisely identical with the points of a geometer's space of n dimensions.' In other words, all of the geometer's figures and relations can be precisely pictured by the relational structure of a selected system of classes or of statements, whose relations are wholly and explicitly logical relations, such as opposition, and whose relations may all be regarded, accordingly, as reducible to a single type of purely symmetrical relation.

Thus, for *all* exact science, and not merely for the logician's special realm, the contrast between symmetrical and unsymmetrical relations proves to be, after all, superficial and derived. The purely logical categories, such as opposition, and such as hold within the calculus of statements, are, apparently, the basal categories of all the exact science that has yet been developed. Series and levels are relational structures that, sharply as they are contrasted, can be derived from a single root.

I have restated Kempe's generalization in my own way. I think it the most promising step towards new light as to the categories that we have made for some generations.

In the field of modern logic, I say, then, work is doing which is rapidly tending towards the unification of the tasks of our entire division. For this problem of the categories, in all its abstractness, is still a common problem for all of us. Do you ask, however, what such researches can do to furnish more special aid to the workers in metaphysics, in the philosophy of religion, in ethics, or in esthetics, beyond merely helping towards the formulation of a table of categories—then I reply that we are already not without evidence that such general researches, abstract though they may seem, are bearing fruits which have much more than a merely special interest. Apart from its most general problems, that analysis of mathematical concepts to which I have referred has in any case revealed numerous unexpected connections between departments of thought which had seemed to be very widely sundered. One instance of such a connection I myself have elsewhere discussed at length, in its general metaphysical bearings. I refer to the logical identity which Dedekind first pointed out between the mathematical concept of

the ordinal number of series and the philosophical concept of the formal structure of an ideally completed self. I have maintained that this formal identity throws light upon problems which have as genuine an interest for the student of the philosophy of religion as for the logician of arithmetic. In the same connection it may be remarked that, as Couturat and Russell, amongst other writers, have very clearly and beautifully shown, the argument of the Kantian mathematical antinomies needs to be explicitly and totally revised in the light of Cantor's modern theory of infinite collections. To pass at once to another, and a very different instance: The modern mathematical conceptions of what is called group theory have already received very wide and significant applications, and promise to bring into unity regions of research which, until recently, appeared to have little or nothing to do with one another. Quite lately, however, there are signs that group theory will soon prove to be of importance for the definition of some of the fundamental concepts of that most refractory branch of philosophical inquiry, esthetics. Dr. Emch, in an important paper in the *Monist*, called attention, some time since, to the symmetry groups to which certain esthetically pleasing forms belong, and endeavored to point out the empirical relations between these groups and the esthetic effects in question. The grounds for such a connection between the groups in question and the observed esthetic effects, seemed, in the paper of Dr. Emch to be left largely in the dark. But certain papers recently published in the country by Miss Ethel Puffer, bearing upon the psychology of the beautiful (although the author has approached the subject without being in the least consciously influenced, as I understand, by the conceptions of the mathematical group theory), still actually lead, if I correctly grasp the writer's meaning, to the doctrine that the esthetic object, viewed as a psychological whole, must possess a structure closely, if not precisely, equivalent to the ideal structure of what the mathematician calls a group. I myself have no authority regarding esthetic concepts, and speak subject to correction. But the unexpected, and in case of Miss Puffer's research, quite unintended, appearance of group theory in recent esthetic analysis is to me an impressive instance of the use of relatively new mathematical conceptions in philosophical regions which *seem*, at first sight, very remote from mathematics.

That both the group concept and the concept of the self just suggested are sure to have also a wide application in the ethics of the future, I am myself well convinced. In fact, no branch of philosophy is without close relations to all such studies of fundamental categories.

These are but hints and examples. They suffice, I hope, to show that the workers in this division have deep common interests, and will do well, in future, to study the arts of cooperation, and to regard one another's progress with a watchful and cordial sympathy. In a word: Our common problem is the theory of the categories. That problem can be solved only by the cooperation of the mathematicians and of the philosophers.

Josiah Royce.
Harvard University.

SCIENTIFIC BOOKS.

The Harriman Alaska Expedition. Vol. X. Crustaceans. By Mary J. Rathbun, Harriet Richardson, S. J. Holmes and Leon J. Cole. New York, Doubleday, Page and Co. 1904. Pp. x + 337. 8vo; with xxvi plates and 128 figures in the text.

In working out the shrimps of the Harriman expedition Miss Rathbun was obliged to review the entire material of that group from northwest America which had accumulated in the National Museum and, in addition to the

results of that study, has provided a check list of the Decapoda inhabiting the coast from southern California northward. An effort has been made to figure all the less known species. When it is considered that the basis of this study includes the rich collections of the U. S. Fish Commission from Lower California to the Arctic; the extensive explorations on the Alaskan coast and the Aleutian islands made by Dall; and the fruit of lesser researches by a large number of collectors and students, including Stimpson, Lockington and Holmes—in all some 50,000 specimens—it can be realized how extensive and valuable an addition to our knowledge of the Crustacea of the north Pacific is embraced in Miss Rathbun's painstaking memoir.

The decapod fauna of the north Pacific is rich in individuals if not in species. Certain types were found in especial profusion, such as the shrimps belonging to the Pandalidæ, Hippolytidæ and Crangonidæ, the hermit crabs, the maioid spider crabs and the Lithodidæ or anomouran spider crabs. The Pandalidæ take the lead in numbers. The most abundant species are *Pandalus borealis* and a subspecies of the Atlantic *P. montagui*, boreal forms which extend southward from the Arctic into both oceans, but seem to find the most favorable environment in the Pacific.

In number of species the genus *Spirontocaris* of the Hippolytidæ is unsurpassed, being represented in the north Pacific by fifty-one species exhibiting great diversity of form, several of which are also common to the Atlantic. Like *Pandalus*, it is essentially a boreal group. The Crangonidæ also occur in great numbers and include thirty-two different forms, mostly restricted to the Pacific. The hermit crabs are also very abundant and to some extent rather local, occurring in their finest development in a special region, outside of which these species are often rare and stunted.

In their distribution many of the Arctic forms continue southward on either shore to the Kurile Islands, on the one hand, or Puget Sound, etc., on the other. As with the mollusks, fishes and marine mammals, the winter line of floating ice in Bering Sea determines the northern limit of many forms. While many species run without interruption from this limit south to California, the distribution of others indicates the possible division of the fauna geographically into subfaunæ, points of limitation being indicated near Kadiak, Fuca Strait and Monterey, California. Some Bering Sea species occur sporadically in the cold waters of glacier-fed bays in southeastern Alaska, where they are, perhaps, relics of that glacial time when the immediate waters of the whole coast were much colder than at present. A few Japanese species also appear sporadically in analogous latitudes on the American coast, without, so far as known, inhabiting the intervening region. The archibenthal species, as was to be expected, have a greater range than those restricted to the more variable environment of the shallow waters of the coast.

The memoir is abundantly illustrated and will be of permanent value to all interested in the natural history of the Crustacea.

Dr. Richardson's paper includes a list of the isopods collected by the Harriman expedition, together with others obtained on the Californian coast by Professor W. E. Ritter. In all, twenty-one species are enumerated, of which five are regarded as new, while the doubtful *Idotea gracillima* is reidentified, figured and redescribed. A *Munna* was taken at the Pribiloff Islands in a state too mutilated to describe, but the presence of a species of this family heretofore unknown from the Pacific coast is a fact of interest.

Dr. Holmes describes six new amphipods and enumerates sixteen others from the collections of the Harriman expedition, most of which are well illustrated, but it is probable that a complete collection would considerably increase this number, these animals being remarkably abundant on the Alaskan coast.

The remainder of the volume is devoted to a report on the littoral Pycnogonidæ of the west coast of North America by Mr. Cole. This covers a field almost entirely new to the literature. Twelve species are described and profusely illustrated, of which one is circumpolar and two others are probably evolved from circumpolar types. The list simply in-

dicates a beginning, as there is an almost unexplored gap between northern California and Prince William Sound, while among the Aleutian Islands pycnogonids are rather abundant, and would probably, on thorough exploration, add considerably to the number of four species now known from that region.

The book concludes with an excellent index and well sustains the high reputation which the earlier volumes of this important series have maintained.

W. H. Dall.

Smithsonian Institution.

Chemie der Eiweisskörper. Von Dr. Otto Cohnheim, A. o. Professor an der Universität Heidelberg. Zweite vollständig neu bearbeitete Auflage. Braunschweig, F. Vieweg und Sohn. 1904.

The first edition of Cohnheim's 'Chemie der Eiweisskörper,' published in 1900, speedily gained a wide circulation among physiological chemists and won for itself a place as a most useful book of reference. No other comprehensive and satisfactory compilation of the literature on proteids had been attempted since Drechsel's article in Ladenburg's 'Handwörterbuch,' published in 1885. The appearance of a new edition by Cohnheim, so completely revised in some parts that it almost deserves to be called a new book, testifies the popularity which the work has enjoyed and above all the rapid progress which the study of proteid chemistry has made in this brief period of four years. An era of classification in which new proteids were isolated and their physical and chemical properties investigated, has been followed by renewed interest in the chemical structure of the albuminous substances. The recent fruitful researches of Emil Fischer, Kossel and others bear witness to the advances which improved methods of study can inaugurate. Accordingly, we find in the new volume an entire chapter devoted to the chemical constitution of the proteids. This, as well as other parts of the book, is characterized not only by the completeness and accuracy of the list of references to the literature, including the earlier pioneer work, but also by the exercise of critique in the presentation of such detailed data. It is this selective and unbiased treatment which makes a compilation readable.

Without attempting any detailed review, it may be of interest to refer to some of the more noteworthy changes or innovations in the present edition. The molecular structure characteristic of the proteids and serving to define them is summarized in the following words:

> Die wichtigste Gruppierung ist nun sicher die oben besprochene Säureamidbindung der α-Amidosäuren, und man kann daraufhin Körper wie das Glycylglycin und seine Homologen als die einfachste Eiweisskörper bezeichnen. Richtiger ist es aber wohl, Kossel zu folgen, und auch die zweite Verbindungsform, wie sie im Arginin vorliegt, als notwendig für den Eiweissbegriff anzusehen. Danach hat man als Eiweisskörper Säureamide aus α-Amidosäuren zu bezeichnen, von denen eine das Arginin ist.
>
> Unter diese Definition fallen zweifellos alle Peptone und auch die komplizierteren Peptide, ebenso die Protamine, deren Abtrennung von den Eiweisskörpern bei den breiten chemischen und genetischen Übergangen zwischen ihnen und den anderen Eiweisskörpern durchaus willkurlich erscheint. Die von Löw und Hofmeister versuchte Heranziehung des physiologischen Elementes hat bei einer chemischen Definition Bedenken und ist unzulässig, seit es wahrscheinlich geworden ist, dass der Tierkörper sein Eiweiss aus allen stickstoffhaltigen Verbindungen aufbauen kann, die für seine Fermente zugänglich sind (p. 71).

The discussion of the physical and physicochemical properties of proteids has been modified to conform with changing ideas. This is especially evident in Chapter V. in the treatment of the salt-like compounds of the proteids. The twofold behavior of the latter towards acids and bases, assigned in the earlier edition to their character as pseudo-acid and pseudo-base (Hantzsch), has given way to a somewhat different interpretation. The unique combining properties of the proteids are now attributed by the author to the amido-acid complexes which form the molecule, since simple amido-acids are known to show precisely similar reactions. In the classification of the proteids no notable change is introduced. Casein is still referred to under the most unsuitable designation of nucleoalbumin, not, however, without at length indicating its specific character as a phosphorus-containing

compound (phosphorhaltiges Eiweiss). The vegetable proteids have not yet received the attention which, in the reviewer's opinion, they deserve. The crystallized vegetable proteids are dismissed with a few words (p. 149) and without any adequate references to the methods of obtaining them, although their preparation has already assumed commercial proportions; the crystallization of egg- and serum-albumin, on the other hand, is carefully considered. It must be said to the credit of Professor Cohnheim that he has, in contrast to most continental writers, shown appreciation of the important work by American investigators in the domain of the vegetable proteids in the present edition.

The greatly enlarged chapter (II.) on cleavage products, beginning with a brief historical review, is excellent in every respect and ought to be warmly welcomed for its exhaustive reference list. The compounds obtained by the action of acids or digestive enzymes are very properly discussed in a separate group as fundamental (primäre Spaltungsprodukte); and the quantitative relations are compiled so far as known. The existence of diaminoacetic acid (Drechsel) is now rendered doubtful (p. 33). In principle the distinction between anti- and hemi-proteid derivatives is still maintained. The chapter on albumoses and peptones has been adapted to the modified system of analysis and nomenclature introduced by the Hofmeister school, the so-called peptids and plasteins also being added. A brief résumé of the behavior of proteids towards the aniline dyes (p. 114) will interest histologists.

The special part of the book, dealing with the individual proteids, is more encyclopædic in character and the innovations are naturally less conspicuous. One receives everywhere an impression of first-hand acquaintance with the literature and must admire the industry and good judgment of the author. Finally, even the most casual examination of this work of three hundred pages can not fail to impress the reader with the growing importance and interest which the study of the proteids is attaining in biology. LAFAYETTE B. MENDEL.

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SCIENTIFIC JOURNALS AND ARTICLES.

The *American Journal of Science* for October contains the following articles:

'New Devonian Formation in Colorado': W. CROSS.

'Upper Devonian Fish Remains from Colorado': C. R. EASTMAN.

'Fossil Turtles belonging to the Marsh Collection in Yale University Museum': O. P. HAY.

'Air Radiation': C. C. HUTCHINS and J. C. PEARSON.

'Uintacrinus and Hemiaster in the Vancouver Cretaceous': J. F. WHITEAVES.

'Separation of the most Volatile Gases from the Air without Liquefaction': J. DEWAR.

'Absorption and Thermal Evolution of Gases occluded in Charcoal at Low Temperatures': J. DEWAR.

'Studies in the Cyperaceæ': T. HOLM.

The Popular Science Monthly for September contains articles on 'The Development of the Theory of Electrolytic Dissociation,' by Svante Arrhenius; the 'Conservation of Human Energy, Preservation of Beauty,' by J. Madison Taylor; 'Art in Industry,' by Frank T. Carlton; 'Some Plants which Entrap Insects,' by Forrest Shreve. This last is very fully illustrated, and calls attention to some of the insects that are adapted for life on or about some insectivorous plants. 'Hebrew, Magyar and Levantine Immigration' is discussed by Allan McLaughlin in an article which is not very encouraging for the United States, in general, and decidedly discouraging to dwellers in New York. Richard L. Sandwick makes a plea for 'More Men (as teachers) in Public Schools,' Charles R. Eastman presents 'A Second Century Criticism of Virgil's Etna' and Robert MacDougall considers 'The Evolution of the Human Hand.' The concluding article, by Simon Newcomb, tells of the International Congress of Arts and Science at St. Louis.

DISCUSSION AND CORRESPONDENCE.

A RECENT PALEONTOLOGICAL INDUCTION.

THE concept of arboreal 'horses' already thrice discussed in the current volume of SCIENCE, or even concepts of fabled Pegasi, are, from a philosophical standpoint, rational and legitimate products of human conscious-

ness. Nevertheless, the probability of such conceptions having had real counterparts in the material world is absolutely *nil*, so far as experience shows, and for like reason we can ascribe only a mythical existence in times past to warm-blooded reptiles, feathered reptiles, or reptiles possessing so eminently bird-like a characteristic as the *gizzard*.

It is, therefore, surprising to find a writer in SCIENCE (No. 501, p. 185) advancing the anomalous conception of reptiles with organs corresponding to the avian gizzard. The solitary fact upon which Mr. Barnum Brown bases his conclusion is the discovery, in a number of instances, of small-sized silicious pebbles in association with plesiosaur skeletons from the western Cretaceous. Certain corollary assumptions, apparently accepted as axiomatic by Mr. Brown, but nevertheless debatable, may be stated as follows:

(1) These 'stomach stones' were contained within the alimentary canal prior to the death of the creatures, and not accidentally deposited upon or with their remains. (2) The stones were intentionally swallowed, and not taken promiscuously with other fare, as might happen in bottom-feeding. (3) They served as a mechanical aid to digestion through the intervention of a supposititious gizzard-like organ. (4) Thin-shelled prey like cephalopods could not have been crushed upon one another without the admixture of a judicious quantity of 'stomach stones.' (5) The non-occurrence of such stones amongst European reptiles proves only that the latter 'had no stomach' for them, not that they were gizzardless. (6) The history of the gizzard (*horresco referens*) shows that it was developed first amongst cold-blooded vertebrates, then lost by them, and afterwards independently acquired by birds. Incidentally it appears that plesiosaurs possessed the most highly specialized digestive apparatus known amongst reptiles, ancient or modern.

For our part, begging pardon of Mr. Brown, we are willing to consign to birds the exclusive enjoyment of gizzards and feathers. A cogent reason for suspending judgment as to the function of 'stomach stones' is found in their limited distribution. Before asking us to believe that all plesiosaurs had 'gizzard-like arangements' (*sic*), let it be shown that all plesiosaurs and related reptiles had the habit of gorging themselves with foreign matter to the extent asserted of American species, and let no doubt remain that these pebbles are not of adventitious origin.

C. R. EASTMAN.

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TO THE EDITOR OF SCIENCE: In SCIENCE for August 5, 1904, at page 184, mention is made of the stones often found apparently in the stomachs of fossil plesiosaurs, with the suggestion that they may be connected with the food habits of the animals with whose remains they are associated. It is of interest to notice that, according to Mr. Hornaday, the stomachs of the west coast sea lions contain rounded pebbles an inch or two in diameter. As their food seems to be somewhat similar to that of the extinct plesiosaurs, a careful study of the sea lion's habits may be of importance to paleontology.

JULIUS HENDERSON.

SPECIAL ARTICLES.

DETERMINATION OF LONGITUDE.

THE recent determination of the difference of longitude between San Francisco and Manila by the use of the cables of the Commercial Pacific Cable Company, by the Coast and Geodetic Survey completed the longitude girdle of the earth, and the results will be published in detail in the 'Report of the Superintendent of the Coast and Geodetic Survey,' for 1904. In anticipation of that report the results are now made public by the authority from the superintendent.

The parties in charge of Assistants Edwin Smith and Freemont Morse started for the field in March, 1903, and finally completed the field work in May, 1904. The distance by cable from San Francisco to Manila (7,847 nautical miles) is covered by four cables extending from San Francisco to Honolulu, Honolulu to Midway Island, Midway Island to Guam Island and Guam Island to Manila. For the purpose of exchanging time signals, the Commercial Pacific Cable Company very generously gave the use of the cables to the survey free of charge and at all the stations extended to the

field parties courtesies and assistance without which the execution of the work would have been impracticable. This was specially the case at Guam and Midway Islands, where the parties were almost wholly dependent upon the cable staffs. The transportation to and from these islands is very infrequent and was the cause of the long delay in the completion of the field work.

In the determination of time at the several stations the method set forth in Appendix 7, of the 'Coast and Geodetic Survey Report,' for 1898 was carried out except that it was impossible to observe the same stars at both stations involved in each determination of a difference of longitude, on account of the great difference of longitude and also the unfavorable weather conditions which often necessitated the observation of different stars on consecutive nights. The stars were selected almost exclusively from the list given in the *Berlin Jahrbuch*, and it is believed that the results must be very little if any in error on account of errors of the right ascensions.

The greatest difficulty to be overcome was the eliminations of the difference of personal equation of the observers.

Since 1891, the Germans have used the Repsold registering micrometer on their transits and their experienced observers seem to have almost no personal equation in its use for the determination of time.

In eight differences of longitude determined by them, 1893 to 1903, an exchange of instruments and observers took place midway in the work of each determination, thus giving a determination of the sum of the differences of instrumental and personal equations.

The following results are taken from the *Astronomisch-Geodatische Arbeiten* of the Preussischen Geodatischen Institutes for 1902 and 1904.

		s
	1898	
Ubagsberg-Göttingen	III. Borrass—II. Albrecht	−0.009
Ubagsberg-Bonn	" "	−0.019
Bonn-Göttingen	" "	−0.034
	1898	
Knivsberg-Kopenhagen	III. Albrecht—II. Schumann	−0.034
Knivsberg-Kiel	" "	−0.033
	1900	
Potsdam-Burkarest	III. Albrecht—II. Borrass	−0.017
	1901	
Potsdam-Pulkowa	III. Albrecht—II. Borrass	−0.025
	1903	
Potsdam-Greenwich	III. Albrecht—II. Wanach	0.000

Had no exchange of place of instruments and observers been made, the errors in the differences of longitude due to personal equation would in no case have been greater than 0.034.

The addition of registering micrometers to the transit of the Coast and Geodetic Survey was considered, but this was found quite impossible in time for the trans-Pacific work.

An exchange of observers took place between San Francisco and Honolulu and difference of personal equation was determined by special observations as often as the observers met. The results are here given. The plus sign means that S observes later than M.

From the exchange of observers between San Francisco and Honolulu, April 20–29 and June 2–13, 1903.

$$S - M = + 0^s.062 \pm 0^s.008.$$

The following are the results from the ten special nights observation:

Locality.	Date.	Stars.		s	s	Wt.
San Francisco	March 28, 1903	20	$S-M=$	+0.085	±0.017	0.7
" "	April 1, 1903	20		+0.092	±0.017	0.7
Honolulu	May 11, 1903	20		+0.109	±0.010	1.0
"	June 27, 1903	20		+0.106	±0.012	0.8
"	April 18, 1904	20		+0.060	±0.009	1.1
"	April 21, 1904	17		+0.079	±0.007	1.4
San Francisco	May 6, 1904	22		+0.075	±0.013	0.8
" "	May 7, 1904	26		+0.045	±0.012	1.0
" "	May 8, 1904	22		+0.043	±0.015	0.8
" "	May 9, 1904	26		+0.087	±0.015	0.8

The mean of the ten nights is:

$$S - M = + 0^s.077 \pm 0^s.005.$$

This result with an assigned weight of 2.0 combined with that determined from the exchange of observers between San Francisco and Honolulu with an assigned weight of 1.3 gives

$$S - M = + 0^s.077 \pm 0^s.007.$$

This personal equation is applied to the differences of longitude between Honolulu-Midway, Midway-Guam, Guam-Manila. The difference of longitude between San Francisco and Honolulu is corrected by the personal equation determined from the exchange of observers only. The range of these results is no greater than should be expected from the computed probable errors and may, therefore, be due to errors of observation rather than to

variation of personal equation. The observers were so placed that personal equation is eliminated in the final longitude of Guam and enters only once in the final longitudes of Midway and Manila. It does not seem that these longitudes can be seriously in error on account of personal equation.

A method of automatically recording time signals over long cables had been successfully used by the Canadian and English observers in the determination of the difference of longitude between Greenwich and Montreal in 1892, but no description of this method was available. A visit was made to the office of the Commercial Cable Co., at New York, where information was obtained which led to the designing and construction at the Coast and Geodetic Survey office, of an apparatus for recording automatically time signals over the cables.

The instrumental outfits of the five stations of the Commercial Pacific Cable Co. are similar. The Muirhead Syphon Recorders are exclusively used, and a description of them can be found in 'Submarine Telegraphs' by Charles Bright. The record is made upon a slip of paper by a syphon pen attached by two fibers to the coil of the recorder. The slip of paper is made to move by an electric motor at the rate of about two centimeters per second. In order that the paper and pen may be adjusted to the proper relation the rollers over which the paper passes are attached to a stand capable of a vertical and two horizontal adjustments. It was necessary that all cable signals should be recorded on this slip of paper at the cable office. The problem was to refer the record of a signal received over the cable to the time as recorded by a break-circuit chronometer. It was solved in the following manner. To the armature of a twenty-ohm Morse relay was attached an arm of aluminum, which carried a syphon pen exactly like the one on the cable receiver. This relay was mounted on a stand capable of a vertical and two horizontal adjustments. This was called the chronometer cable recorder. It could be placed on the table in front of the cable receiver and so adjusted that its syphon pen would record on the slip of paper parallel to the record made by the pen of the cable recorder. The chronometer and battery being put in circuit with the chronometer cable recorder, a record of the chronometer seconds was made on the slip and any signal coming over the cable was recorded by the pen of the cable recorder also on the slip. This cable signal could be brought vertically down to the record of the chronometer and its time read off by the usual scale. On account of the impracticability of always adjusting the pens exactly opposite each other, the cable signal has a correction, the determination of which will presently be explained. Signals were sent by a key such as is used in correspondence over the cable. It is a double key by which a positive or negative current can be sent to the cable. An attachment was made to these keys at the Coast and Geodetic Survey office by which the circuit through the chronometer recorder would be broken the instant the current was put on the cable and thus record the chronometer time of the signal sent. When sending signals the local cable receiver is generally disconnected, but by so arranging a shunt that a small portion of the sending current would pass through the coil of the local receiver a sharp record was also made by the pen of the cable receiver and thus the relation of the two pens was obtained.

At the stations San Francisco, Honolulu and Manila the observatories were so far from the cable office that the chronometer cable recorder at the cable office could not be placed in circuit with the chronometer at the observatory. Another chronometer was, therefore, placed at the cable office to be used in the exchange of the cable signals. At these stations the cable offices and observatories were connected by land lines by which the two chronometers were compared before and after the exchange of cable signals. At Midway and Guam the cable offices and observatories were only a few hundred feet apart, so that the chronometer cable recorder at the cable office could be placed directly in circuit with the chronometer at the observatory and no comparisons of local chronometers was necessary. The results indicate that time signals over long cables can now be exchanged with as great accuracy as over the best land lines.

By the transmission time of a signal over a cable is meant the time that elapses from the instant the record is made on the slip at the sending station to the instant the record is made on the slip at the receiving station. These times as determined from sending signals in both directions over the four cables are given in the last column of the following table. The other data in the table have been kindly furnished by Mr. G. G. Ward, the vice-president and general manager of the cable company.

	Diameter of Copper Conductor.	Length of Cable in Nautical Miles.	Resistance of Copper.	Electromotive Force used.	Transmission Time.
	Inch.		Ohms.	Volts.	s
San Francisco Honolulu	0.1801	2 276 3	5,054	50	0.189
Honolulu-Midway	0.1122	1 332.0	6,580	30	0.118
Midway-Guam	0.1830	2,606.9	4,758	50	0.1°5
Guam-Manila	0.1183	1,631.6	7,235	35	0.156

The following are the differences of longitude corrected for personal equation as determined over these four cables:

	h	m	s	s
San Francisco-Honolulu	2	21	38.919	± 0.008
Honolulu-Midway	1	18	03 219	± 0.015
Midway-Guam	2	31	53 584	±0.010
Guam-Manila	1	34	43 263	± 0.010

The San Francisco station is $8^h\ 9^m\ 48^s.813 \pm 0^s.056$ west of Greenwich (see 'The Longitude Net of the United States and its Connection with that of Europe, 1866–1896,' Appendix 2, Coast and Geodetic Survey Report, 1897, and also 'The Transcontinental Triangulation,' pp. 820 and 826, Coast and Geodetic Survey Special Publication, 1900). The Manila station is $0^s.224$ west of the dome of the Manila Cathedral, which is the accepted point of reference in Manila. Combining these with the above differences of longitude, we have the following longitudes:

	h	m	s	s
Honolulu Transit west of Greenwich	10	21	27.752	± 0.05
Midway Transit west of Greenwich	11	49	30.951	± 0.057
Guam Transit east of Greenwich	9	38	35.465	± 0.058
Manila Cathedral dome east of Greenwich	8	03	52.425	± 0.059

Comparisons with former determinations of the longitudes of the several stations.

Honolulu.—In a former issue of this paper* an elaborate discussion of former determinations of the longitude of Honolulu was given by Mr. J. F. Hayford, of the Coast and Geodetic Survey, to which the reader may refer. We will give here only the most reliable one. In 1874 Captain G. L. Tupman, Royal Marine Artillery in charge of the British Transit of Venus Expedition of that year, determined the longitude of his station by seven results from occultations of stars by the moon, fifty-two results from observations of moon culminations and sixty results from the observations of zenith distances of the moon combined with the observed culminations and zenith distances of well-known stars. His result officially communicated to the Hawaiian government is $10^h\ 31^m\ 27^s.2$.

The longitude determined by the Coast and Geodetic Survey by the cables referred to the same point is $10^h\ 31^m\ 27^s.236$, a remarkably close agreement.

Midway Islands.—These islands were discovered by Capt. N. C. Brooks in the *Gambia*, July 5, 1859. In 1867 Capt Reynolds, U.S.N., in the *Lackawana*, visited the islands and gave the longitude of the north point of the larger island as:

Longitude 177° 18′ 20″ west.

h	m	s
11	49	13.3

In 1900 a survey was made of the islands by the officers of the U. S. S. *Iroquois*, under the command of Lieut. Commander C. F. Pond. The Hydrographic Office Chart No. 1951 is based upon this survey and the longitude given for the point marked Observation Spot is:

Longitude 177° 21′ 30″ west.

h	m	s
11	49	26 west.

The longitude determined by the Coast and Geodetic Survey by the cables referred to the same point is:

Longitude 177° 22′ 46.″4 west.

h	m	s
11	49	31.091 west.

Guam Island.—In 1819 M. de Freycinet in the French corvettes *L'Uranie* and *La Physicienne* made a survey of the southern part of the Mariana or Ladrone Islands and gave the longitude of Fort Santa Cruz in the harbor of San Luis D'Apra, Guam Island, as:

* November 6, 1903.

144° 39′ 45″ east.
h m s
9 38 39 east.

(See Findley's 'North Pacific Directory,' p. 800.)

In 1875 the island was visited by Capt. Knorr, of the German Navy, in the ship *Hertha*. The longitude of Fort Santa Cruz was determined to be:

144° 39′ 30″ east.
h m s
9 38 38 east.

See *Annalen Hydrographie*, 1875, p. 284, and also of geographical positions compiled by Lieut. Commander Green and published by the Hydrographic Office, U. S. N., 1883.

In 1899 the officers of the U. S. S. *Yosemite* made a survey of the harbor of San Luis D'Apra. They built a concrete pier on Fort Santa Cruz and determined its longitude by transit observations and the transportation of chronometers back and forth from Yokosuka, Japan. The longitude of this pier as communicated by the hydrographic office is:

Longitude 144° 39′ 21″.45 east.
h m s
9 38 37.43 east.

The longitude determined by the Coast and Geodetic Survey by the cables referred to the same point is:

Longitude 144° 39′ 42″.15 east.
h m s
9 38 38.81 east.

Manila.—Two former telegraphic determinations of the longitude of Manila can be deduced, one *viâ* Madras, India, and the other *viâ* Vladivostock, Siberia.

The longitude of Madras has been determined by five independent series of observations and a résumé of them has been given by Capt. Burrard in Appendix No. 2, Vol. XVII. of the 'Great Trigonometrical Survey of India.' They are as follows:

	h m s	s	
Series *A*	5 20 59.750	±0.155	1874–5 and 1881-2.
B	5 20 59.010	±0.163	1874.
C	5 20 59.137	±0.022	1876, 1881, 1892–4–5.
D	5 20 59.223	±0.127	1874–7.
E	5 20 59.421	±0.123	1884–7.

Series *A* is *viâ* Pulkowa, Moscow and through Siberia to Vladivostok by the Russians and thence to Madras by the U. S. Navy. As the series will be used for the deduction of the longitude of Manila direct, it will not be considered in the determination of the longitude of Madras.

Series *B*, *D* and *E* were mostly determined by the parties who went out to observe the transit of Venus in 1874, and it is stated that the observations were not conducted with the refinement necessary for the determination of fundamental longitudes. It therefore seems at the present that series *C* must be considered the only reliable determination of the longitude of Madras. It is made up of ten differences of longitude in which personal equation was eliminated by the exchange of observers or by special observations. The observers were also so placed that in the final longitude of Madras personal equation would be eliminated. One link in this series is the difference of longitude between Potsdam and Greenwich and this was redetermined in 1903 by the Germans in most refined manner and the result increases the longitude of series *C* by 0ˢ.098. This increased result will be used in the deduction of the longitude of Manila.

The difference of longitude between Pulkowa-Greenwich was redetermined by two steps, Pulkowa-Potsdam and Potsdam-Greenwich, by the Germans in 1902–3. This work supersedes the older determinations and will be here used. The difference of longitude Vladivostok-Pulkowa is made up of thirteen differences of longitude by the Russians. In all the work between Vladivostok and Greenwich personal equation was eliminated as in the case of Madras.

In 1881–2 the differences of longitude of Vladivostok-Manila and Manila-Madras was determined by officers of the U. S. Navy. The entire work consists of ten differences of longitude. Seven of them are involved in the difference of longitude Vladivostok-Manila and four in the difference of longitude Manila-Madras. In this work the differences of longitude are not corrected for personal equation and no information as to the value of personal equation of the observers that can now be used can be found. The endeavor was made to so place the observers that personal equation would be eliminated as far as possible in the

resulting longitudes. The difference of longitude Vladivostok-Manila remains uncorrected for plus the difference of personal equation of two of the observers, and the difference of longitude Manila-Madras remains uncorrected for plus twice the difference of personal equation of the same two observers. The two results for the longitude of Manila are as follows:

	1.	
	h m s	s
Manila Cathedral Dome-Madras, U. S. Navy,	2 42 53.000	± 0.057 + 2 (*N.-G.*)
Madras-Greenwich, English and Germans,	5 20 59.238	± 0.022
Manila Cathedral Dome-Greenwich,	8 03 52.238	± 0.061 + 2 (*N.-G.*)

	2.	
	h m s	s
Vladivostok-Manila Cathedral Dome, U. S. Navy,	0 43 38.500	± 0.059 + (*N.-G.*)
Vladivostok-Greenwich, Russians and Germans,	8 47 31.197	± 0.146
Manila Cathedral Dome-Greenwich,	8 03 52 697	± 0.157 − (*N.-G.*)

The symbol (*N.-G.*) indicates the unknown personal equation correction to these determinations of the longitude of Manila. Owing to this unknown correction, it is difficult to give proper weights to these two values of the longitude of Manila to combine them with the value recently determined by the Coast and Geodetic Survey *viâ* United States. It is probable that the value of (*N.-G.*) is plus and the corrections, if known, would bring the two longitudes of Manila closer together. Taking the mean of the two values, we have:

	h m s
Manila Cathedral Dome-Greenwich	8 03 52.468 + ½ (*N.-G.*).

which differs only 0ˢ.042 or 61.7 feet from the Coast and Geodetic Survey result.

In 1881–2 the U. S. Navy adopted for the longitude of Madras 5ʰ 20ᵐ 52ˢ.42, which gave for their value of the longitude of Manila 8ʰ 03ᵐ 52ˢ.42. This value, which differs only 0ˢ.006 or 8.8 feet from the Coast and Geodetic Survey result, has been used since 1882.

The difference of longitude San Francisco-Manila determined by the Coast and Geodetic Survey has a probable error of ± 0.022. The longitude of San Francisco depends upon the longitude net of the United States and its connection with that of Europe, and includes seventy-two differences of longitude between forty-five points. Four of these differences of longitude are trans-Atlantic, three by the Coast and Geodetic Survey and one (1892, not yet published) by the English and Canadians. In view of these facts and the unknown correction for personal equation in the other two values of the longitude of Manila, the value determined by the Coast and Geodetic Survey will be accepted.

EDWIN SMITH.
COAST AND GEODETIC SURVEY,
September 2, 1904.

BOTANICAL NOTES.

SYSTEMATIC NOTES.

Two new blackberries (*Rubus vermontensis*, and var. *viridifolius*), allied to *Rubus argutus*, are described by W. H. Blanchard in the July number of the *American Botanist*. They occur in southern Vermont.—The July number of the *Fern Bulletin* contains an annotated list of the ferns of Kentucky by the late Miss S. F. Price. Thirty-eight species of ferns and four lycopods are included.—Professor E. L. Greene continues the publication of his 'Leaflets,' the last fascicle (pages 49–64) bearing date of August 25, 1904, and including systematic discussions pertaining to *Cactaceae*, *Gentianaceae*, *Apocynaceae*, *Cichoriaceae* and *Rhamnaceae*.—In the August number of *Torreya* Dr. N. L. Britton describes a new alder (*Alnus noveboracensis*) from Staten Island.—Mr. C. G. Lloyd's 'Mycological Notes' for June include some interesting paragraphs in regard to the herbaria of Kew, the British Museum, Linnaean Herbarium, Leiden and Berlin, as well as personal notes about some of the botanists now or formerly associated with these collections.—Mr. E. P. Bicknell continues his studies of *Sisyrinchium* in the June *Torrey Bulletin*, describing five new species from California. In the same journal Dr. P. A. Rydberg describes twenty-five new species and varieties of flowering plants from the Rocky Mountain region.—W. A. Murrill continues his series of papers on the *Polyporaceae* of North America in the August *Torrey Bulletin*, and separates the following new genera from *Polyporus*, viz., *Abortiporus*, *Cyclomy-*

cetella, Cycloporus, Globifomes, Nigrofomes and *Poronidulus.*

STUDIES OF SEXUALITY IN BLACK MOLDS.

Every student of botany in the last quarter of a century has given some attention to the black molds (*Mucoraceae*), some species of which are so common as to be obtainable for laboratory use at any season of the year. Yet while every one has been able to study the gross anatomy of black molds, and the formation of their interesting conidia, their zygospores, which are still more interesting, are so difficult to obtain they have rarely been available for study. Whether we regard the sexual organs of black molds as primitively isogamic, or as essentially heterogamic with a degradational approach to isogamy, they are interesting objects of study in the laboratory. Anything which will make it easier to secure these structures is to be regarded as of much importance scientifically and practically. This service has been rendered by Mr. Albert F. Blakeslee in a recent paper published by him in the *Proceedings of the American Academy of Arts and Sciences* (Vol. XL., No. 4, August, 1904), under the title of 'Sexual Reproduction in the Mucorineae.' A preliminary summary of the results of this paper was published in Science, June 3, 1904, and we now have the full account. The present paper contains about 120 pages of text, and is accompanied by four plates aggregating fifty-eight figures. Here are given the details of many experiments undertaken by the author in order to determine the cause or causes of zygospore formation. The ingenuity of some of these experiments must command the admiration of every one who reads the paper. It will be remembered that the most striking result of Mr. Blakeslee's experiments has been the discovery that zygospores of the black molds may be obtained by growing different strains side by side, the zygospores appearing where the hyphae of the two strains intermingle. The practical importance of this discovery will be appreciated by all who have laboratories in which students are at work. The author promises to continue his studies, and reserves an extended discussion of certain problems 'until he has accumulated a greater body of facts on the subject.'

EGG FORMATION IN GREEN FELT (VAUCHERIA).

Dr. Bradley M. Davis has made a careful study of egg-formation (oogenesis) in a species of green felt (*Vaucheria*), one of the common fresh-water algae, and published his results in the August number of the *Botanical Gazette.* These plants have great numbers of minute nuclei which are not separated by walls, and when the lateral protrusion forms in which an egg is finally to develop, it also contains a large number of nuclei. This protrusion (oogone) is soon separated from the rest of the filament by a cross-wall which forms when it is about two thirds its full size. About this time there sets in a degeneration of nuclei resulting in the disappearance of all but one, so that the oogone is eventually uninucleate. The single nucleus increases rapidly in size until 'in the mature egg it is three or four times as large as the original nuclei in young oogonia.'

The author calls attention to the essential agreement of the process of egg formation in *Vaucheria* with those of certain phycomycetetous fungi (*Saprolegnia, Phythium, Peronospora, Plasmopara, Sclerospora, Albugo* and *Araiospora*). He discusses the relationship of *Vaucheria* to other green algae, suggesting its derivation from ancestors whose oogonia were multinucleate. The relationship of the water molds (*Saprolegniales*) and downy mildews (*Peronosporales*) presents some difficulties, but the author calls attention to the fact that they possess many points of similarity to *Vaucheria.* Their relationship to the molds (*Mucorales*) is more obscure, but here again similarities are not wanting. The paper is very suggestive, and will repay careful perusal.

RECENT FORESTRY BULLETINS.

Three bulletins (numbers 47, 48, 49) of much more than ordinary interest have been issued recently by the United States Bureau of Forestry. In the first Professor Bray, of the University of Texas, discusses the 'Forest Resources of Texas.' He calls attention to

the vast area included within the boundaries of Texas, and the great diversity in all the factors (latitude, elevation, soil, rainfall, temperature, sunlight, winds, etc.) which have to do with forest distribution. For example, the rainfall in the eastern part of the state is over fifty inches, diminishing regularly to about ten inches in the extreme west. So too the surface rises from sea-level along the gulf to the high plains 4,000 to 5,000 feet higher, and to mountains which reach an altitude of nearly 10,000 feet. On this diversified surface the forests have been distributed in a most varied pattern. The 'short-leaf pine' occupies a large area two to three counties wide in the northeast, the 'long-leaf pine' a similar area in the southeast, while west of the latter is an area of 'loblolly pine.' In the region west of the Pecos River are small areas of Rocky Mountain conifers. Belts of live oak forests alternate with post oak nearly halfway across the state from southeast to northwest, at last passing into the mesquite and chapparel of central and western Texas. In addition to the forests of the general surface, there are the 'hardwood forests' (composed of oaks, ash, hickory, walnut, gum, elm, cotton wood, linden, maple, osage orange, etc.) of the alluvial bottom lands bordering the streams of the southeast half of the state. A list of sixty 'valuable timber trees' native to Texas is compiled by the author, who adds notes on their distribution, habits and uses.

A second paper by Professor Bray (Bulletin 49) is entitled 'The Timber of the Edwards Plateau of Texas,' and deals with the southernmost province of the Great Plains region where it ends abruptly at the Pecos River and the escarpment line extending easterly from its junction with the Rio Grande. The annual rainfall averages twenty-five inches, being as high as thirty-three inches on its easterly side, and sinking to fifteen inches on the west. The air humidity is usually low, the annual evaporation amounting to more than fifty inches. On this region the forests are slowly spreading, or as the author expresses it, there is 'a transition from grass to woody growth.' The trees which make up the forest areas on the plateau belong chiefly to the Atlantic type, and include elms, live oaks, post oak, walnut, pecan, sycamore, green ash, hickory, soapberry, etc. From the Rocky Mountains have come the pinon pine, two or three cedars and several oaks. The author devotes a considerable space to a discussion of the encroachment of the forests upon the open lands. "Though the encroachment of timber on the prairie is gradual and insidious, to those whose observation covers a space of twenty-five years the change is truly startling. Where at the beginning of that period the prairie held undisputed sway, the observer now finds himself shut in by miles of oak scrub on every side. Men who drove cattle in the early days say that they rode across an open country from above Georgetown to the Colorado breaks, in Williamson County. This same region is now all heavily timbered."

The third paper (Bulletin 48) is on 'The Forests of the Hawaiian Islands,' by W. L. Hall, of the bureau, who made a reconnoisance of the forests of the islands in 1903. The paper opens with the statement that there are two very distinct kinds of forests on the islands, one on the drier lowlands near the sea, and the other on the mountain slopes where there is a heavy rainfall. The first of these consist of the single introduced tree, *Prosopis juliflora*, known as 'algaroba' on the islands. It is the 'mesquite' of Texas and Mexico, and was introduced by Father Bachelot, in 1837. From the original tree, which is still standing, it is now estimated that at least 50,000 acres of forest have sprung, 'fairly well distributed over the different islands.' The native forests, which constitute the type and occur on the mountain slopes, "are distinctively of tropical character. None of the familiar trees of the north temperate zone are present. The observer looks in vain for oaks, maples, pines or spruces." Popular descriptions are given of the more important trees, lehua (*Metrosideros polymorpha*), koa (*Acacia koa*), mamane (*Sophora chrysophylla*) and kukui (*Aleurites triloba*). Attention is called to the decadence of the forests, due to the inroads of cattle, goats, insects and fire and in many places to destructive cutting. The danger of a further reduction of the forest area is

discussed and a far-sighted forest policy is recommended. The setting aside of forest reserves and the exclusion of stock is advocated, as well as the planting of certain areas. The paper is a most valuable contribution to our knowledge of the forests of these islands.

CHARLES E. BESSEY.

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*DECLARATION OF THE NATIONAL EDUCATIONAL ASSOCIATION.**

1. We can not emphasize too often the educational creed first promulgated more than a century ago that 'religion, morality and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged.' This declaration of the fathers must come to us now with newer and more solemn call when we remember that in many parts of our common country the fundamental questions of elementary education—local taxation, consolidation of weak schools, rational supervision, proper recognition of the teacher as an educator in the schools system, school libraries and well trained and well paid teachers—are still largely unsettled questions.

2. We would direct attention, therefore, to the necessity for a supervisor of ability and tact for every town, city, county and state system of public schools. Not only are leaders needed in this position who can appreciate and stimulate the best professional work, but qualities of popular leadership are also demanded to the end that all classes of people may be so aroused that every future citizen of the republic may have the very best opportunities for training in social and civic efficiency.

3. The very nature of the teacher's task demands that that task be entrusted only to men and women of culture and of intellectual and moral force. Inadequate compensation for educational work drives many efficient workers from the school room and prevents many men and women of large ambition for service from entering the profession. It is creditable neither to the profession nor to the general public that teachers of our children, even though they can be secured, should be paid the paltry sum of $300 a year, which is about the average annual salary of teachers throughout the country.

4. The Bureau of Education at Washington should be preserved in its integrity, and the dignity of its position maintained and increased. It should receive at the hands of our lawmakers such recognition and such appropriations as will enable it not only to employ all expert assistance necessary, but also to publish in convenient and usable form the results of investigations; thus making that department of our government such a source of information and advice as will be most helpful to the people in conducting their campaigns of education.

5. We would emphasize the necessity for the development of public high schools wherever they can be supported properly, in order that the largest number possible of those who pass through the elementary grades may have the advantage of broader training, and for the additional reason that the public elementary schools are taught largely by those who have no training beyond that given in the high schools.

6. As long as more than half of our population is rural, the rural school and its problems should receive the solicitous care of the National Educational Association. The republic is vitally concerned in the educational development of every part of its territory. There must be no forgotten masses anywhere in our union of states and territories, nor in any one of its dependencies.

7. We believe that merit and merit alone should determine the employment and retention of teachers, that, after due probation, tenure of office should be permanent during efficiency and good behavior, and that promotions should be based on fitness, experience, professional growth and fidelity to duty. We especially commend the efforts that are being made in many parts of the country whereby teachers, school officials and the general public working together for a common purpose are securing better salaries for teachers and devising a better system for conserving the rights and privileges of all and for improving the efficiency of the schools.

* St. Louis, Mo., July 1, 1904.

8. We declare further that, granted equal character and efficiency, and equally successful experience, women are equally entitled with men to the honors and emoluments of the profession of teaching.

9. We advocate the enactment and rigid enforcement of appropriate laws relating to child labor, such as will protect the mental, moral and physical well-being of the child, and will be conducive to his educational development into American citizenship.

10. The responsibility for the success or failure of the schools rests wholly with the people and therefore the public schools should be kept as near to the people as practicable; to this end we endorse the principle of popular local self-government in all school matters.

11. Since education is a matter of the highest public concern, our public school system should be fully and adequately supported by taxation; and tax laws should be honestly and rigidly enforced both as to assessment and collection.

12. We congratulate and thank the management of the Louisiana Purchase Exposition for giving education first place in the scheme of classification, for the location and grandeur of its building, and for the extent and arrangement of the educational exhibits. Such recognition of education is in harmony with the genius of our democracy and will stimulate interest in popular education throughout the world.

APPEAL FOR COOPERATION IN MAGNETIC AND ALLIED OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE OF AUGUST 29–30, 1905.

THOSE who are in position to take part in above cooperative work are earnestly requested to make the necessary preparations and to put themselves in communication with the undersigned.

As this will be the best opportunity for some time to come to further test and observe the magnetic and electric phenomena which have been found to occur in connection with total solar eclipses, and as these phenomena are destined to play an important rôle in the theory of the variations of the earth's magnetism and electricity, ascribed to outside forces, it is very much hoped that all countries through which or near which the belt of totality passes will organize and send in the field observing parties.

Owing to the minuteness of the expected magnetic effect, the burden of proof as to its association with the eclipse will largely consist, as in the two previous eclipses, in the connection of the times of the magnetic effects with the times of passage of the shadow cone at the various stations. The observing parties, therefore, should be distributed at intervals along as much of the entire belt as possible.

The above is merely a preliminary notification of the work proposed. Fuller details and suggested directions to be followed will be given later.

L. A. BAUER,
Director.

Address: *Department of Terrestrial Magnetism, The Ontario, Washington, D. C., U. S. A.*

THE COTTON BOLL WEEVIL.

LAST year the chief of the Bureau of Plant Industry prepared, by direction of the secretary, a general plan of work to meet the damage caused by the Mexican cotton boll weevil. With this plan as a basis, the sum of $250,000 was appropriated and became available early in February of this year. The work was divided in the department, part being assigned by the secretary to the Bureau of Plant Industry, and part to the Bureau of Entomology. During the summer the investigations have been pushed forward vigorously by both branches of the department. The department has cooperated with state authorities in locating and taking action upon sporadic outbreaks of the weevil. The farmers in the state of Texas have been thoroughly organized and more than 5,000 have grown cotton under the improved conditions recommended by the department. This work has been in charge of Dr. S. A. Knapp, of the Bureau of Plant Industry, with headquarters at Houston. Extensive work on the improvement of varieties has been inaugurated, the work being conducted by the Bureau of Plant Industry mainly at Terrell, Texas. In order to encour-

age the growing of other crops, diversification farms have been established. This work is being handled by the agrostologist of the department. The results of Mr. O. F. Cook's work in the discovery of the kelep ant have already been announced in these columns. The effects of the general propaganda work in Texas have been good, as many farmers have succeeded in growing good crops of cotton despite the presence of the weevil.

SCIENTIFIC NOTES AND NEWS.

THE registration at the International Congress of Arts and Science was as follows:

Foreign speakers	87
Officers and principal American speakers	306
Ten-minute speakers	138
General registration	1,851
Total	2,382

COLUMBIA UNIVERSITY has conferred the degree of D.Sc. on Sir William Ramsay, the retiring president, and on Mr. W. H. Nichols, the president-elect of the Society of Chemical Industry.

PROFESSOR HUGO DE VRIES, of the University of Amsterdam, gave an illustrated lecture on 'The Origin of Species, illustrated by the Evening Primrose,' at the New York Botanical Garden, on October 1. On October 3, he was given a farewell reception at the American Museum of Natural History.

AT the opening exercises of the one hundred and fifty-first academic year of Columbia University on September 28, Professor Woodward gave the address, taking as his subject 'Academic Ideals.'

IT is announced that the first series of the Hertzstein lectures at the University of California will be delivered in October, by Dr. A. E. Taylor, professor of pathology. The lectures have been made possible through the generosity of Dr. M. Hertzstein, of San Francisco, who fully equipped the physiological laboratory and endowed the lectureship for the discussion of special problems in scientific medicine. Professor Taylor's subject will be 'Ferments and Fermentations.'

MAJOR B. F. S. BADEN-POWELL arrived at New York on the *Campania*, on October 1. He has brought with him kites that he will exhibit at the St. Louis Exposition.

MR. THOMAS H. KEARNEY, of the Bureau of Plant Industry, U. S. Department of Agriculture, has been authorized to proceed to North Africa and other Mediterranean coast regions for the purpose of securing new seeds and plants adapted to the southwest. A special study will be made of the date and new introductions of this fruit will be undertaken. Alkali-resistant forage crops will also be studied and the introduction of seeds of new and promising kinds will be made. Mr. Kearney will remain abroad until next spring.

THE Military-Medical Academy at St. Petersburg has recently installed a portrait of its honorary member, General Kuropatkin, in the main hall as a token of gratitude for his gifts. The academy owes to him the remodeling and enlargement of several of its scientific departments.

THE relief expedition, under Mr. W. S. Champ, which has undertaken for the second time to reach the *America*, after going as far as 79° north was driven back by the ice. The *America*, under the command of Mr. Anthony Fiala, has not been heard from for a year, but there is said to be no anxiety concerning it.

PROFESSOR ROBERT KOCH has been presented with a portrait bust and a Festschrift on the occasion of his sixtieth birthday.

THE funeral of Professor Niels Finsen, the discoverer of the light cure for lupus, took place on September 27. The Kings of Denmark and Greece were present, and there were special representatives from Emperor William, King Edward and other rulers.

MR. ARTHUR D. WYMAN, assistant in chemistry at Harvard University, was killed by an automobile on September 28.

MR. B. M. EVERHART, the botanist, died at West Chester, Pa., on September 22, at the age of eighty-seven years.

THOSE having reprints of the late Dr. Greeley's paper on 'The effect of variations in the temperature upon the process of artificial parthenogenesis' (published in the *Biological*

Bulletin, February, 1903), which they are willing to dispose of are requested by Professor Starbird, Washington University, St. Louis, Mo., to communicate with him.

AN additional appropriation of $75,000 for the continuation of construction work at the New York Botanical Garden, voted by the Board of Estimate and Apportionment on June 24, 1904, became available by the signature of His Honor Mayor McClellan, on August 9, 1904. It is expected that the expenditure of this money will complete all the driveway bridges and their approaches, and all, or nearly all, of the driveways laid down in the general plan of the garden, approved by the board of managers and by the department of parks on June 21, 1897.

THE daily papers state that Mr. Archer M. Huntington has had incorporated the Hispanic Society of America, and has made to the trustees a gift of $1,000,000. The gift consists of a building to be erected in Audubon Park, New York, which will cover about eight city lots, a suitable endowment, and an extremely valuable collection of Spanish books, paintings, manuscripts and objects of archeological interest now in the Huntington library at 'The Pleasance,' Bay Chester.

THE Austrian Meteorological Society has received from the Emperor of Austria the right to use the letters 'K.K.,' equivalent to Royal Imperial, before its name, so that its official designation now becomes the 'k.k.Oesterreichische Gesellschaft für Meteorologie.'

THE International Pure Food Congress held its session at St. Louis last week.

THE fifteenth annual general meeting of the British Institution of Mining Engineers was held at Birmingham beginning on September 14. There was a good attendance of members from various parts of the kingdom, and in addition there were present between 50 and 60 visitors from the Association des Ingénieurs Sortis de l'Ecole de Liége. The Secretary, Mr. M. Walton Brown, submitted the annual report of the council, which stated that since the formation of the institution in 1889 the membership had increased from 1,239 to 2,704. The secretary announced that Sir Lowthian Bell had been elected president for the ensuing year.

A CORRESPONDENT writes to the London *Times* that the second International Philosophical Congress was held at the University of Geneva from September 4 to 8, and was attended by 500 members, representative of every school of philosophic thought in Europe. The congress was presided over by the venerable Swiss philosopher, M. Ernest Naville. At the inauguration of the congress Professor Gourd, of the Faculty of Philosophy at the Geneva University, referred to the excellent results of the first congress held in Paris, in 1900, from the point of view of the teaching of philosophy, and of obtaining additional information of the nature and value of the divers philosophical works of our age. Professor Boutroux, of l'Institut Paris, read a paper on 'The Rôle of the History of Philosophy in the Study of Philosophy.' Professor Stein (of the University of Berne, and Gourd (of the University of Geneva) dealt with 'The Definition of Philosophy'; Professor Windelband (of Heidelberg) with 'The Present Task of Logic and Philosophical Inquiry in Relation to Natural Science and Culture'; Professors Vifredo Pareto (of Lausanne) and De Greef (of Brussels) with 'The Individual and Society'; and Professor Reinke (of Kiel) and Giard (of Paris) with 'Neovitalism and Finality in Biology.' At the sectional meetings the subjects under discussion were 'The History of Philosophy,' 'General Philosophy and Psychology,' 'Applied Philosophy,' 'Logic and Philosophy of the Sciences' and 'History of the Sciences.'

THE Ben Nevis Observatories will be closed. Mr. R. T. Ormond, the honorary secretary, explains that two years ago the directors stated that they could not continue to carry on the observatories any longer under existing conditions. The meteorological council at the same time resolved to withdraw £250 of the £350 given by them. But the appointment of a committee of inquiry into the administration of the parliamentary grant for meteorology led to an effort being made to continue the work at the observatories until the committee had reported. The meteorological council

therefore continued their grants of £350 for two years, and the directors obtained from a gentleman interested in the work sufficient funds to carry on the observatories, in the same manner as hitherto, till October of this year. The committee issued their report a few months ago, but as in it they only recommended a continuance of the old grant of £350, the directors sent a letter to the First Lord of the Treasury asking for an additional grant of £600 to defray that part of the annual expenditure which has up to this time been met by subscriptions. In reply the treasury refused an additional grant, but offered to pay the £350 recommended by the Committee of Inquiry direct to the Scottish Meteorological Society on behalf of the Ben Nevis Observatory, instead of making this sum a charge on the meteorological grant. The continuance of the observatories could only be undertaken on a guaranteed income of £1,000 a year. The Treasury has only offered £350 a year, and the directors have therefore no choice but to close the observatories.

We learn from the *Bulletin* of the American Geographical Society that the Paris Geographical Society has just issued, under the legacy of Renoust des Orgeries, the first number of the 'Documents Scientifiques de la Mission Saharienne,' by F. Foureau, chief of the expedition. It contains the astronomical and meteorological observations of the expedition, and will be followed by reports on topography, geology, biology, ethnology, and archeology. The accounts of the winds and thunder-storms and some other phenomena are especially minute. This legacy is to be applied to the aid of expeditions planned to bring the interior of Africa under the influence of France and make a homogeneous whole of her actual possessions in Algeria, Senegal and the Congo.

A Welsh national conference of delegates appointed by the Welsh county councils to discuss the questions of afforestation in the principality met recently at Swansea, Sir Charles Philipps, the chairman, says the London *Times*, in referring to the great importance of the study of forestry, said that the object of that meeting was to consider how best to advise the county councils. After reference to the report of the departmental committee of 1902, the speaker said that there was in Wales an enormous area which could be profitably afforested, and pointed to the fact that afforestation gave employment to ten men, where sheep farming would only give employment to one. It was necessary that professors of the subject should be appointed at the universities and that practical demonstration areas should be set apart. One of the latter had been already established on high meadow-land in the Forest of Dean. The view was expressed, in course of discussion, that the establishment of a central school of forestry for Wales was of the utmost importance, and that such a school would become self-supporting after a few years. It was at length resolved that the members should urge on their respective councils the great importance of the study and practical application of forestry by providing lectures to be given at suitable centers and bursaries, enabling students to attend these lectures; also that a central school of forestry be established with example plants of three or more acres, and demonstration areas of suitable extent, and that the necessary expense be defrayed by the county councils on the basis of their respective ratable values, the whole amount now asked for not to exceed £5,000. It was further resolved to communicate what was being done to the government department, in the hope that a grant from the state would be made towards their efforts.

It is stated in the *Bulletin of the American Geographical Society* that Mr. Shimpei Kamase has presented to the society's library an excellent photograph of his relief map of the Japanese Empire, which is attracting much attention in the Transportation Building at the St. Louis Exposition. This map, about 100 feet in length by 50 in width, is so large that clear idea of relief features is given without very great exaggeration of the vertical scale. The exaggeration is threefold—sufficient, of course, to distort in some measure the mountain features, but it does not give the observer the grossly-erroneous impression of the topography that is conveyed by not a few

relief models where the vertical is five to eight times as large as the horizontal scale. The map, made at Fukuoka, the home of its designer, is based upon the general staff map, and the results of the topographic surveys have been carefully reproduced in this miniature representation of the mountains, valleys, plains and seas of the island empire. Every place of any importance is indicated; and the map gives a vivid idea of the remarkable development of Japan in postal, railroad, telegraph and steamship enterprises.

THE quarterly return of births, deaths and marriages for England and Wales has been published by authority of the registrar-general. The population of the United Kingdom in the middle of 1904 is estimated at 42,786,466 persons; that of England and Wales at 33,763,434, that of Scotland at 4,627,656 and that of Ireland at 4,395,376. In the United Kingdom 300,358 births and 164,534 deaths were registered in the three months ended June 30, 1904. The total increase of population was, therefore, 136,424. The number of persons married in the quarter ended March 31, 1904, was 118,968. The birth-rate in the United Kingdom in the second quarter of 1904 was 28.2, and the death-rate 15.4 per 1,000. The marriage-rate in the first quarter of 1904 was 11.2 per 1,000. According to the returns issued by the Board of Trade, it appears that 118,830 emigrants embarked, during last quarter, from the several ports of the United Kingdom at which emigration officers are stationed, for places outside Europe. Distributing proportionally 1,158 emigrants whose nationality was not ascertained, the emigrants that were natives of the United Kingdom numbered 76,294, of whom 47,054 were English, 11,648 Scottish and 17,592 Irish, while 42,536 others were of foreign nationality. The proportions of emigrants accredited to the several parts of the United Kingdom, per million of the respective estimated populations, were as follows: England, 1,394; Scotland, 2,517; and Ireland, 4,002. Compared with the averages in the three preceding second quarters, the proportion of English emigrants showed an increase of 27.2 per cent., that of Scottish emigrants an increase of 46.3 per cent., and that of Irish emigrants a decrease of 1.4 per cent.

ACCORDING to the *Scottish Geographical Journal* some interesting notes on the researches of Dr. David, a naturalist apparently of Swiss nationality, in the Congo forest and the western flanks of the Ruwenzori range, are given in a recent number of *Globus* (vol. 86, No. 4). The traveler has distinguished himself by being the first European to secure a specimen of the okapi with his own gun, which will permit for the first time an accurate knowledge of the physical characters and general bearing of the animal. According to Dr. David, the specimens which have been set up in this country and Belgium have been incorrectly treated, which, all things considered, is not surprising. The okapi, although a ruminant, has all the bearings of a tapir, not at all that of an antelope. The markings are much finer than those of the zebra, the stripes being black within white, and almost all double. The back is reddish, especially in the male, the ears enormously long, the mane erect. Some specimens of both sexes possess horns, while others are entirely without, and Dr. David is on this account inclined to distinguish two species. The animal stands from 4 to 5 feet high at the withers. Another find which is interesting from a zoological point of view is that of an armadillo 4 feet long, closely resembling its congener of the pampas. It frequently assumes an erect attitude, supporting itself on its tail and holding the tree-trunks with its powerful fore claws. Dr. David has also ascended the western slopes of the Ruwenzori range to a height which he estimates at 16,700 feet, which, if correct, would be the greatest altitude yet attained. His routes seem to have led somewhat to the north of Dr. Stuhlmann's. The range, he says, is composed of a series of ridges of granite, diorite and diabase, no traces of basalt or porphyry being seen. The snow-level occurs at about 14,500 feet, but glacier-tongues reach down to about 13,000. Two small moraine-lakes were seen, and a little below them was a third lake of milky-green color, surrounded by thick vegetation; while a fourth, which was fed by glacier streams, was clear, though of a

greenish-brown color, perhaps derived from the neighboring moorland. Like other visitors to the range, Dr. David attempts to define the zones of vegetation met with, of which he distinguishes six or seven, though the uppermost four, above the zone of bamboos, all form moorland of one sort or another. The *Senecio Johnstoni* was found up to 12,800 feet. There was a striking absence of flowers, and of the lush dwarf vegetation characteristic of the Alps. Trees ascend higher on the wall-like sides and slopes of the mountains than on the crests and ridges, but no distinction could be traced between slopes exposed to wind, rain or sun, and the reverse. The vegetation observed on the glacier-tongues on which 3 feet of new snow was lying was of interest, the *Senecio Johnstoni* growing with its base almost in the ice, and its roots embedded in the ground-moraine, which was frozen at the surface, though of a higher temperature below. Dr. David hopes to continue his researches in this region.

UNIVERSITY AND EDUCATIONAL NEWS.

THE daily papers state that about $300,000 is left to public institutions by Mrs. Elizabeth Green Kelly, including $100,000 to the University of Chicago.

THE increased appropriations for Miami University by the legislature of the state of Ohio at its last session have rendered it possible to enlarge the Science Hall, given by Senator Brice, '63, to about three times its present capacity. The new Brice Hall will be occupied by the departments of chemistry, physics and biology of the Liberal Arts College and by the natural history department of the State Normal School. The $40,000 dormitory for women, also authorized by the legislature, is in process of construction.

THE will of Mrs. Sarah B. Potter, of Boston, contains public bequests aggregating over $1,000,000, including $150,000 to the Boston Medical Library, $100,000 to the Kindergarten for the Blind, at Jamaica Plains, and $50,000 to Harvard University.

A NEW building, to cost $100,000, is to be built on the campus of the University of Southern California at Los Angeles. It will be devoted to the science departments.

G. C. FRACKER, A.M. (Iowa), professor of psychology at Coe College, has been granted leave of absence to take the assistantship in psychology at Columbia University, vacant by the call of Mr. Henry A. Ruger to the chair of psychology at Colorado College. Mr. Frank G. Bruner, assistant in psychology at Columbia University, has been given leave of absence until the close of the Louisiana Purchase Exposition, where in the absence of Dr. R. S. Woodworth, instructor in psychology, he has charge of the Anthropometric and Psychometric Laboratories. Mr. F. L. Wells, A.B. (Columbia), has been appointed acting assistant for this period.

THE following appointments have been made in the Albany Medical College: Dr. Richard Mills Pearce has succeeded Dr. George Blumer as professor of bacteriology and pathology; Dr. Spencer L. Dawes, adjunct professor of materia medica; Dr. Wilfred S. Hale, demonstrator of anatomy and assistant curator of the museum; Dr. Edwin McD. Stanton, lecturer on histology; Dr. Howard E. Lomax, instructor in anatomy; Dr. Charles K. Winne, Jr., instructor in bacteriology; Dr. George G. Lempe, instructor in anatomy; Dr. Donald Boyd, demonstrator in anatomy of the nervous system; Dr. Edward F. Sibley, instructor in clinical microscopy, and Dr. Silas L. Filkins, prosector of anatomy.

ACCORDING to the London *Times* Mr. Ernest Shearer, M.A., B.Sc., Kirkwall, has been appointed lecturer on agriculture at the Pusa Imperial College, Bengal. This agricultural college for all India, with a farm of 1,300 acres attached, is one of the developments resulting from the appointment two or three years ago of another Scotsman, Mr. James Mollison, as inspector-general of agriculture in India. Mr. Alexander Sangster, Montrose, has been appointed junior assistant with the Abukir Land Reclamation Company, near Alexandria, Egypt, and Mr. John C. Leslie, B.Sc., has been appointed assistant conservator of Forests in Southern Nigeria.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 14, 1904.

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*MENTAL SCIENCE.**

WE have great reason to congratulate ourselves on the progress of psychology, not only in this country but in the world during the last quarter of a century. Not only have students, teachers, text-books, journals, societies, laboratories and monographs increased, and new fields have opened and old ones widened, but our department has been enriched by original contributions that have profoundly modified our views of mind and even of life itself. For the first time in this field American investigators have borne an important and recognized part in advancing man's knowledge of the soul. Among these we take pride even in the presence of our distinguished foreign guests in naming first of all James, who, more than any other American, has occupied and influenced the psychological thought of both experts and students here for a decade, and whose charming personality and style have done most to infect cultivated laymen in all adjacent fields with interest in psychology and to make American thought known and respected abroad; Ladd, to whom we owe the first text on physiological psychology in English and who, more than any other American, illustrates the old tradition of a system of philosophic thought large enough to embrace most of the topics from the laboratory to religion; Münsterberg, who has not only done more than any of his distinguished Teutonic predecessors from Agassiz and Lieber down to make Germany and America know and respect each other, but has been the first to lay the foundations of a new efferent system of thought which harmonized the best in Fichte and Schopenhauer with the choicest results of the laboratory; Titchener with his thorough Eng-

* Address before the Division of Mental Science, International Congress of Arts and Science, Universal Exposition, St. Louis.

lish training, whose ceaseless productivity makes him already in the widening fields he cultivates our American Wundt in a thoroughly and sometimes radically reconstructed and improved edition; Baldwin, the first here to attempt a logic of biology and sociology and evolution that should apply to genetic psychology; Dewey, who, much as he achieved in logic and general psychology, has done perhaps yet more to make these topics fruitful for education; Cattell, pioneer in founding two laboratories, the foremost editor in our ranks, who has boldly grappled the vast problem of individual psychology in a way which, if solved, must make even biography more scientific; in other related fields Royce, Ormond, Howison, Fullerton, Strong, who have done so much to restore the faltering belief in soul, freedom, God and ultimate reality; Cowles, Donaldson, Myer, Hoch, Herrick, each marking advances either in exploring the obscure psychoses of mental aberration, advancing our knowledge of the brain, correlating psychic symptoms and neural and somatic changes, and making the asylum tributary to science—these inadequate references, not to mention my own associates or even the score or two of younger men whose work already gives promise of a future richer in results than the past, and omitting, solely because I am too ignorant to speak of it, the department of sociology, bracketed with ours to-day, but which has also made advances perhaps hardly less signal—these suggest my theme, which is simply a plea for yet more differentiation and specialization between men, departments and institutions, and certain modifications of method in our rapidly widening field.

The idealist who holds that the world is man's concept and that all science is a part of psychology can hardly object to the far more modest claim that it really does properly include logic, ethics, religion, esthetics, epistemology and metaphysics, and those who with Lotze still cling to that dear old tradition of the theoretic life that its supreme joy is to attain the fullest expression of one's own personality in a comprehensive philosophical system, must not carp if one who long since abandoned the youthful hope of attaining this felicity vents his own individuality a little, as, with your kind indulgence, I beg leave to do, excused somewhat by the conviction that all systems, the most meager and the best alike, are only human documents, empirical data, votes, résumés, returns, to be used at last as empirical data for some greater synthesis of the future. If psychology is already far more than a subdepartment of physiology, anthropology and psychiatry, or a subsection in a philosophical system as of old, if we may justly reject for it the place assigned it in the hierarchy of Compte and Spencer as a link between biology and sociology and now base it no less upon the latter than upon the former, and not only claim for it an independence already achieved, but look forward to its ultimate hegemony in all the fields involving man's higher nature, or as being in a word the culmination of humanism, it follows that we must regard all that all of us have so far done as only a prelude, that much of our work must be done over again, that the history of philosophy, instead of being philosophy itself, is to be subordinated as psychological material for a truer and far more comprehensive natural history of mind, and that the best of us are only morning stars which will pale and be forgotten as day advances.

If the germs of soul are as old as life itself and if its types are as distinct and as persistent as those of morphology, then, though we can no more define it than we can life, must we not draw the momentous inference that consciousness alone is a very partial and inadequate organ of experience

and at best only one culminating stage, like a submarine plant's leaves and blossoms that alone reach the surface? Does not experience by its very nature tend to lapse below the threshold of consciousness, and just in proportion as it becomes complete does it not sink beyond the reach of subjective analysis? Nay, more; does it not so strongly tend to become automatic that to become perfect it must lose even the power to be transmitted by instruction, but only by heredity? If so, must we not supplement the methods of internal by those of external observation, subjective by objective, and deductive by empirical researches? Just as history is now studied more as the daily life of the average man and as the play of but half-understood economic racial and telluric forces, and less as the mere records of battles and the acts of kings and courts, so must not psychology more and more center in the study of love, pity, fear, anger, pride, conscience, beauty, love of power and wealth, sympathy and all those social instincts that make our life their sport? Should we not find helpful biological suggestion in the example of Bateson and his growing circle of followers, who would go back to facts baldly recorded to lay broader foundations for their pyramid, instead of steepening its angles to a tower or inverting it, and be content in some fields with a merely descriptive psychology that masses facts, not ignoring those that now seem most trivial, registering reflexes that, perhaps, appear but once in a lifetime, vascular and other somatic resonances that seem meaningless, in the hope that ultimately we may be able to infer something about the psychic states that once animated them and do something to restore the great volume and variety of lost soul and life that mechanism, missing links and extinct species, animal and human, have taken out of the world?

For myself, if I were challenged by some advocate of a psychology without a soul to improvise a working hypothesis of what soul may be like, I might boldly begin by assuming it to have been more potent in the past than it is in the present, but ever tending to vanish as heat, which once made the earth incandescent, does to dissipate itself; as something with which the deathless germ plasm is more instinct than are the somatic organs it evolves, even the brain where it has now taken refuge; as something no less closely related than theology once made the persons of the Trinity to be among themselves with the *nisus formitivus*, whatever that is, which when the world was young and lusty evolved all the products of natural selection, developed and then differentiated hunger and love, adapted flowers and insects to each other, made instinct and inspired all its purposive acts without the aid of any sense of purpose, was shaped by all the forces that have modified life since it began; that domesticated useful and tried to exterminate noxious animals and plants, invented thousands of languages the syntax of some of the lowest of which are the new marvels of philologists; that laid down the lines of the primeval religions and struck out all the unwritten laws and customs of social animals and tribal men, the latter more complex and perfect in many respects, as a recent English blue book on Africa insists, than any that civilized legislators have yet devised. On this view soul life when it was chiefly passion, feeling, impulse, may have been far more dominant over the body and all its processes than now. It was hot, intense, lived out close to the elements, always in sight of the edge of the fierce struggle for survival. It was more life than thought, more collective and racial than individual, shaped the world from within rather than, as science is now learning to do, perhaps, in a derived and secondary way, from without. Everything

was genetic, nothing logical, while as yet no symptom of the great paralyzer, self consciousness, had appeared. This was the great reality which our late developed and senescent, ingrowing intellect has lost and yearns for as old age yearns for its vanished youth. Its traces, fossils, remnants, still abound in our own body and soul and in life about us, but unless we can read our titles clear to this pleroma of life abounding, the psychologist will still have reason to grieve as an exile from his pristine paradise vainly seeking atonement with God, the world and self. Some type of soul life has passed out of the world with every species that became extinct, every vanished tribe, with every child that develops into maturity, with every substitution of self-consciousness and reflection for the naïve, intuitive, spontaneous, and what we call the progress of knowledge is a compound of mingled gains which we keenly feel with losses that we far less keenly realize.

When the intellect, which seems to have been developed late, as a new function of adaptation to the external world, leaves the latter and seeks to introspect its own processes and reflect upon them, it crosses some important pons. This involution is hard, slow and with many stages. Perhaps first are the half-instinctive musings on some memory-content of conduct as affecting pleasure and pain, or upon motor impulses, or the somatic stages that accompany thought are more vividly sensed. Many laboratory experiments directed to other ends have as their best result the revelation of the intricacy of the simplest psychic operations. We find a mazy network of tentative associations and impulses struggling for survival or for emergence into the narrow focus of attention, chaotic irruptions into saner sequences of perception or thought, manifold shades or elements which language is far too clumsy and conventionalized to adequately express, distractions which must be ignored by an act of the will as we ignore all that is in the indirect field of vision. From all this we select out the few and meager factors we want. But if, instead of doing so, we yield to the diverticula and seek to note all that takes place within, we soon feel that we are sane only by a small working majority of our activities, and that underneath the cosmos of habitual sequences and reasoned thought lies a vast and rank chaos of unorganized elements that defy order, analysis or even description. Some are new and some, perhaps, older than history or even than man; some strong and compelling and some so pallid and imperceptible that many experimenters hardly suspect their existence, some congruent and some diametrically opposed to each other. But the tropical sea and jungle are not more rank with life. From all this we realize in a new and deeper sense that conscious mind is only a rather superficial product of gradual and half-unconscious selection, from all this vast seething psychic activity within, of those factors that are practical or most needed for the present conduct of life. Old systems and adjustments to earlier conditions are ever disintegrating and left to lapse and ruin, although they long reverberate in the subliminal field, echo in feeling tones or on occasion have sudden resurgence in automatisms, outbreaks of passion or insistent ideas and impressions, or are injected like dikes into otherwise coherent conduct or thought. The power of survival of these rudimentary organs and processes of the past life of the soul is prodigious. Perhaps they never quite vanish even asymptotically. If the purest science is the completest description of origins and stages of development, psychology may, perhaps, never be complete.

Leaving these, must we not hence infer that the conscious soul we know was evolved solely as an organ to regulate practical life;

that there is no criterion of truth, save its value as a guide to conduct; that the sciences of nature and of mind are, can be and mean only a system of rules for right living and thinking; that to ask what the world and soul are *per se* is an extravasation of the intellect which was kindled only to shed light upon the supreme problem of how to feel and act aright and to which it is subordinate as means to end; that to ask what mind and nature are *per se* and apart from all use by heart and will is paranoiac or a new scholastic entity cult, because the end of science as well as the only real essence of mind is service? Thus the quest of absolute reality must always end in the solipsistic involucre, which is only a new definition of zero, and pure thought purged of will, feeling and sense can not be an object of psychological study, for it does not exist.

Mathematics, which is a formulation of the properties of time and space in the sensory, applies at most only to motion and force in time and space, and its objects are at the bottom, where those of psychology are at the top of the scale of evolution and complexity. From Pythagoras down to Herbart, Fechner, the hedonistic calculus in ethics which the vilest wretch may master without feeling the faintest impulsion to virtue, the Boolean and even common deductive logic which never yet discovered anything, and, indeed, I think, every attempted application of mathematics to psychology, save only for the simple algebraic or other treatment of statistical data, have later proved an illusion if not a mere affectation, and we owe to-day no more to any concept susceptible of mathematical formulation than modern physiology does to the old iatric school that so elaborately treated the bones as levers, the muscles as pulleys, circulation as hydrodynamics, digestion as trituration, and insisted, as Plato did for philosophy, that geometry was the best preparation for the study of medicine. Perhaps no two types of mind have less in common than the mathematical and the psychological or help each other less and may hurt each other more. The former has given us hosts of defunct definitions, categories and dogmas, and has constructed world-bestriding systems by concatenations of the high *a priori* kind in a way that must raise the query in every candid and impartial mind whether in the field of mind the precept 'truth for truth's sake' is not as dangerous as the dictum 'art for art's sake' has proven in its, and whether, beside the old injunction 'physics, beware of metaphysics,' we should not erect the warning 'psychology, beware of mathematics,' and make due purgation of both its methods and its ideals.

Thus, the first and, perhaps, the chief danger to psychology as a science to-day seems to me to be its tendency, as by an iron law, to gravitate to methods that are too abstract, deductive, speculative and affectively exact. Other sciences long since threw off the influence of the old systems, many of which had dominated them, but psychology is still permeated by them. It still feels the charm of the old insolubilities of ultimate reality, of the relation of mind and body, parallelism or interaction, the primacy of feeling or somatic changes, and is dominated more than it knows by interests in the soul's future, by teleology, freedom *versus* necessity, all of which, so far as we see, can never be problems of scientific psychology because they can not be answered. The modern psychologist, too, can be neither materialist, idealist, positivist, dogmatist, gnostic or agnostic, or, rather, is at the same time all of these in some way or degree. Such problems have a large and very important place in the history of philosophic thought. Their culture value as disciplines is very great, but they belong to a stage of mentation now passing

away and doomed perhaps ultimately to become as *ueberwundene Standpuncte*, as those of vortexes, the plenum or vacuum, the Plutonic *versus* the Neptunic theories, have become for science. The ethical bearings of many of these questions once thought so great are rapidly becoming insignificant, but they still bulk large wherever psychologists are dominated by theological interests, or even accept, as far more do, their problems at the hands of metaphysics. Our science is still, like Milton's tawny lion, pawing to get free from the soil in which it is just being born. Many text-books and treatises modulate from the latest science to the oldest speculative surds and speak in two alternating registers, while others evaluate new results by their bearings upon antique problems wrongly put in a pre-scientific age, but made venerable and most significant for history by the accretions of the best and most ingenious thought of ages. Thus, the second danger that besets our work is that it is not sufficiently emancipated from the now conventionalized criteria of past systems of thought, and has not subordinated these as it should to be used not as finalities or solutions, but only as empirical data for larger generalizations that transcend them. But if it is the philosophy of philosophy, it comes to many of these problems not to destroy, but fulfil.

The third source of danger to psychology arises from the theory of knowledge or epistemology. The human soul inherits the result of a vast experience acquired by the race but innate in the individual, but the latter can not validate much of it in his own restricted life. He is so surcharged with paleoatavistic traces, tendencies, instincts, from back, perhaps, to the amphioxus or even the amœba, that he often seems to himself to live and move in a world that is both within and without unrealized, alien and afar. What we inherit is so much better organized than what we acquire, it is so dominant and, perhaps, so unmodifiable and unaccountable, that the world and self seem shadowy, and our unreflecting confidence in these is thus easily shocked out of its poise by Berkeley and Hume till some come to feel that a life so unexplained is hardly worth living. When, in addition to these predisposing causes which for some diatheses may become a neurosis, the thinker leads a pallid, anæmic life in academic isolation from the great, throbbing, struggling world, and in the study devotes himself to passionless contemplation pampered by the second-hand knowledge of life derived from books, it is not strange in a precocious and over-civilized age with more knowledge forced upon the mind than it can digest, that the veil of Maya sometimes settles fold on fold over the soul till it almost feels the panic of the claustraphobiac and must break out and away to find reality or smother. It feels that, like the Holy Grail, removed from the sight of carnal men, it can be sought only by those purged from all defilement of the world of sense, but it must be found and quaffed or the soul be lost to truth. For those paranoiac minds sitting thus in prison, whose constitutional malady is aggravated by the doctrine of the ideality of space, the greatest philosophic delusion of modern times, it is well to have highways of escape opened up out of agnosticism. For many, if not most, too, a touch of it but not too much of it is, perhaps, a necessary part of the complex initiation of youth into its world, but the severer types of this discipline seem more suited to senescent than to adolescent men and races. For the psychologist, however, in pursuit of his legitimate vocation, to be liable to be held up at any time to prove that the soul has a brain or a body, that the self or the objects of sense exist, that other people and animals with similar organs to his own

have similar subjective states, is just as irrelevant and as paralyzing as it would be for the physicist, chemist and astronomer, and any old answer makes just as little real practical difference of any conceivable kind in the one field as in the other. Yet the need of such a cult and all its symptoms, how they came to arise and how very real they sometimes are, and their forms of documentation in both the oriental and the modern world, constitute not only a very important but a fascinating problem for inductive psychology, while the ways of meeting these needs are legitimate and now even pressing questions of the higher individual pedagogy.

Finally, as to the field and methods of scientific psychology, the present speaker feels profoundly limitations that prevent him from rising to the height of the great argument for unification so wisely proposed in the plan of this congress, and can only briefly indicate a view perhaps yet more personal than what has preceded, recognizing that very different ones are held by many if not most of his wiser colleagues. First, no trace of sentiency, even the faintest, down to and perhaps even into the plant world, should be alien to our interest. If in doubt between Wasmann and Forel, on one hand, and the mechanical interpretations of the tropisms and taxies as held by Loeb, Bethe and Uexkull, we should recall and profit by the fate of Descarte's conception that even the higher animals were only automata. In experimenting on these, under the controlled conditions of the laboratory, we should not neglect the observations of the field naturalists nor ignore even the more valuable of the contributions of our agricultural stations, economic zoology, the stock farm and the menagerie, men hunters, etc. Studies here need sympathy as well as controlled conditions. We also want compends of what is known of each of the important animals and birds nearest to man, and to make contact with dynamic or functional biology in its efforts to pass beyond morphology and investigate life, histories, habits and causes of variation, postulating that the manifestations of instinct are just as differentiated and as persistent as those of morphology itself. No philosophic prejudice should make us forget that animals have the same will to live, love of offspring, fear, anger, jealousy, individual attachments, memory, attention, knowledge of locality, home-making instincts and senses that we do. Nor should we deny that empirical methods, whether they have yet done so or not, are quite capable of giving sufficient evidence for the existence of psychic powers as radically different from our own as those claimed for photodermatism or the topochemical sense of the antennæ of ants. Not only, then, might the old maxim, 'Psychologus nemo nisi physiologus' be now also with much propriety reversed, but physiological psychology is now expanding both ways toward a larger biological philosophy, and studies of life and mind will henceforth be more and more inseparable just in proportion as genetic or evolutionary conceptions pervade our field.

Child-study, which began so crudely and has long since silenced many, though not yet all, of the objections raised against it, has already demonstrated its practical value for education, and is acquiring a place of its own in the literature of other departments, especially pathology, philology and criminology, and is beginning to prove itself a key of unsuspected value in unlocking problems connected with the prehistoric development of the race, supplementing studies of the adult mind somewhat as embryology does anatomy and histology. It has not only made new connections between our work and the above departments, but is steadily developing a logic which, though as yet unwritten, is

destined in my own fond belief to become an instrument of great value in reinterpreting the bionomic law of recapitulation, shedding new light upon early developmental stages, and thus giving psychology a genetic perspective which it has so sadly lacked in the past. Students in this field are impregnating insignificant and transient acts, expressions and feeling with new meanings. This work still suffers from the fact that, like the Renaissance, the Reformation and to some extent Darwinism itself, it had to begin outside academic circles, which are now so rapidly opening to it, and develop popular interest and momentum before it could attain scientific methods. It has thus survived and profited by a volume of honest criticism which would have swamped a less vital movement, and that too by many of the very ablest of our craft who did not at first fully understand its scope and value. Now, although we might point with justifiable pride to its books, journals, chairs, its body of results that all accept, we believe that far greater results lie in the near future, and sometimes some of us indulge in dreams of a new dispensation of psychology doctrine with evolution more evolved as its center.

Again, a new alliance is now cemented with the psychological side of anthropology and even ethnology. With almost no academic representation or support, it is our government that has developed a body of scholars that in the study of the Indian have, in the language of another, 'set the world its best example of gathering and recording the myths, customs, rites, occupations and modes of life, thought and feeling of the decadent, yet the most representative of all the races of the stone age.' Psychologists are learning to profit by this work and also to extend their interest to every such record of the sentiments, habits, social organizations and superstitions of primal man. As a naturalist delights in new species, so we more and more both need and desire to profit by every new account that sheds light on how the remotest aborigine thinks, feels and acts, and we do it with a psychic tension and exhilaration as if some great correlation with other allied fields impended. We feel a closer bond with sociology because it, too, is coming rapidly into rapport with anthropology and finding the key to so many of its problems in tribal and other consanguineous forms of early society. The reciprocal suggestiveness of this department with psychogenesis is already beginning to bear fruit.

So in mental and moral alienation we have a few precious and detached studies of psychic symptoms in individuals that are almost classic. The older epoch-making interpretations of epilepsy by Hughlings-Jackson, new views of hysteria, paranoia, a choice fresh little literature on *dementia præcox*, a large collection of records of delusions, hallucinations, automatisms and other phenomena of the borderland between sanity and insanity, gathered at the behoof of an obsolescent hypothesis, but interpreted in a way that has happily called attention to subliminal processes and also the methods of their exploitation by hypnotism. Many of these phenomena are devolutionary; others are normal states magnified by disease as if it were a microscope. Criminology, meanwhile, has shown us feral man in our midst and given a copious anthology of facts about degeneration and perversion, many of which could now be used to make the teaching of practical ethics more interesting and effective. It is high time that mental perversions should be represented by chairs in our medical schools, especially if they are to make headway against quacks and mind-curists, save the profession from some of the tragic experiences just recorded so vividly in the confessions of Veresaeft, teach the medical

student that there is something to be learned outside bacteriology and anatomy, and qualify him to dominate the mind as well as the body of his patient, particularly in a land and age when psychic and nervous complications are more and more involved in diseases. We should not forget the old adage of Hypocrates, 'Godlike is the doctor who is also a philosopher,' which will also bear reversing, and if the psychologist does not study very much anatomy, save the brain and its general structure, the new conception of which he should know, he must give much attention to physiology and have its latest results accessible. At least the psychiatric clinic where nature performs her tragic experiments should always supplement those of the laboratory.

All religions tend to decay, and must be incessantly revived and newly dispensed lest they become raucous and weazened in dogma, conventionalized in rites and rituals, and lose power over individuals, communities and nations, and become divorced from science and life. The multiform symptom-groups of religious pathology are a sad but fascinating chapter only just beginning to be written. Sacrifice and totemism, the faith and prayer states of mind, asceticism, renunciation, miracles of healing, psychology of sects, Sabbath, saints, vows and oaths, the conviction of sin, confession, ecstatic states, worship, the God idea in its many forms, the relations between religion and morals—these and many more old problems, as they begin to be restated in psychological terms, beam with a new light like the cherub faces in old canvases awaiting reincarnation, which they must have if religion is ever to be again made interesting and influential for cultivated men. These themes demand a treatment quite apart from any problems of historicity and should especially be represented in our theological schools, whose pupils ought to have some conception of what the soul they try to save is. Even the so-called philosophy of religion represented by Ritschl and his divergent pupils has not got beyond the restatement of judgments of worth as suggested by Kant's practical critique.

In fine, revolutionizing as the thesis may seem to many, I believe psychology should now be dominantly inductive and practical. Even the old systems, grand as they were, must, as I said, be treated as data of a higher order, whose makers thought they were doing one thing but turned out to have done something very different. Instead of laying bare the constitution of the universe they were only documenting their own souls with unusual fulness for the benefit of the future generalizer. Their work, suggestive as it is, was precocious, and their conclusions premature, and about all of it must be done over again on a larger basis of facts, and our watchword must be not merely back to Kant or even Aristotle, but back to a reexamination of the primitive events of soul life, gathered by the most systematic outer and inner observation, and even from history, literature, experience and wherever psychic life is most voluminous and intense, pain, misery, famine, war, revolutions, shame, revivals, every passional state in which Despine says all vice and crime originate; love, fervid as Dante knew it, crowds, the struggles of the individual soul with besetting sin, which is the original form of dualism as experienced from Paul and Augustine down to poor Weininger, who lately shot himself because he could not overcome the evil within which his almost Manichean system set over against his ideals of goodness. Especially as we advance from the study of sense and intellect to that of the will and feelings, the anæmic thinker, who can realize in his own person so little of the stormy life of man, must seek every possible contact with it. He must live where

he can among animals, children, defectives, the insane, criminals, paupers, saints, sinners, the sick, the well; must know grief and joy—these, as well as the clinic and the laboratory, for here he fronts the bottom facts of the world. Next, he must supplement his at best meager first-hand experience with the proxy experience of others as recorded in books. Psychology lives not merely in the study, but where doubt and belief, sanity and inherited insanity, struggle together; where temptation and conscience wage their wars, in the mob, the cloister; where rage, terror and pity become convulsive and sweep all before them, and where love of the lie usurps that of the truth. Once it was thought that the study of pure should precede that of applied science, but we are now coming to almost reverse this maxim in education. So psychology, especially in our practical age and land, must first study and teach how to live, love, learn, labor; must have something to say to all who reflect on reproduction, disease, health, and thus must first serve man well if it would later rule him wisely. If this view be correct we must abandon many supposed certainties and finalities, and with faith in a future far greater than the past has been, devote ourselves to severe and unremitting toil perhaps for generations; must often practise that hardest of all forms of self restraint in our field—the suspense of judgment—assured that in the end psychology is to become queen of those sciences that deal with man, and reign among all the humanities somewhat as chemistry and physics are coming to do over the material world, with a method, perhaps, sometimes no less exact and certain than these already have. So we shall at last attain a true metaphysics of realities behind sense and feeling which is the necessary crown of all science when it becomes complete.

G. Stanley Hall.

*PRESENT PROBLEMS OF ORGANIC CHEMISTRY.**

There is a strong tendency on the part of some chemists, at the present time, to claim that chemical science in the true sense includes only such portions of our knowledge as can be stated in accurate mathematical terms. One distinguished representative of this school of chemistry has said, 'It is not in the province of science to explain phenomena,' and another has written, 'It is not a part of its ultimate object (*i. e.*, of natural science) to acquire knowledge in regard to mentally conceived existences, such as the atoms of matter, or the particles of luminiferous ether, which are of such a magnitude and character as to lie far beyond the limits of human perception.' I think that nearly all of those now actively engaged in working over the problems of organic chemistry would dissent strongly from these statements. Long experience in dealing with the cumulative, non-mathematical evidence upon which our knowledge of chemical structure is founded has led to a very firm conviction that human knowledge is not bounded by the limits of sense-perception. We are inclined rather to the view that, while there are, undoubtedly, many things which will always remain beyond any direct cognizance of our senses, yet, so far as these have a real existence we may in the end secure, regarding them, very practical and positive knowledge. It is impossible to conceive that those theories with regard to structure which have guided the work of thousands of chemists for the last fifty years do not in some measure express the actual truth with regard to atoms and their relation to each other in organic compounds.

Let us follow, for a few moments, in very brief outline, the steps which have led to the present standpoint. So far as the mat-

* Read at the International Congress of Arts and Science in St. Louis, September 21, 1904.

ters which interest us most are concerned, there was practically no knowledge of organic chemistry before the nineteenth century. The first steps were, of course, the preparation of pure substances and the development of accurate methods of analysis. In both of these fields Liebig was the great master. The formulæ which were calculated were, at first, of little value except to check the accuracy of the analyses and as a simple expression for empirical composition. I need not dwell on the confusion which existed throughout the first half of the century because there was no agreement as to the basis for molecular weights or atomic weights nor upon the large part played by the study of organic compounds in finally clarifying the view of chemists upon these matters. Yet, in spite of this confusion, two discoveries of fundamental importance date from this period: (1) That the empirical composition alone does not fix the nature of a compound, *i. e.*, the fact of isomerism; (2) that certain groups of atoms may remain together in passing from one compound to another through a whole series. The first fact furnishes one of the strongest reasons why an empirical formula for an organic compound is not enough, and the second fact furnishes the most important experimental basis at the foundation of our structural formulæ.

The studies of this period furnished a knowledge of the empirical composition of many natural products and of the products obtained from these by oxidation, reduction and the action of various agents. But while some might, perhaps, be inclined to look upon this mass of empirical knowledge as the most valuable acquisition of that time and to think that the theories in vogue were so imperfect or erroneous as to be of no value, such a view is certainly superficial. There were plenty of chemists in that day, too, who were ready to decry theories which seemed to them worthless, and it is interesting to read to-day what the great Laurent said upon this matter. He wrote in 1837:* "If I could believe that the purpose of my work was only to find a few new compounds or that it would end in my being able to say that there is an atom more or less in this compound or that, I would give it up on the spot. Only the desire of finding an explanation for some phenomena and of proposing some more or less general theories can give me the courage to follow a course in which I have found so little encouragement and where I have met with so many obstacles to overcome." Any one who has followed the story of how the older theories of radicals paved the way for the theory of types and of how the typical formulæ were so easily transformed into structural formulæ when the fact of valence was once grasped, can not fail to see that the larger and fuller view is an outgrowth from the earlier theories. And we must acknowledge that Laurent was right and that the theories upon which he was working were of vastly more importance than the mass of empirical facts which furnished him with their scaffolding.

Do not misunderstand me. There were two theories of radicals at that time—one which devised radicals in the study which should accord with the electrochemical theories held at the time and which did not attempt to secure evidence of their existence from the conduct of the compounds containing them, another which kept in much closer touch with the facts discovered in the laboratory. It was only the latter theory which contributed much to the growth of our knowledge. A theory which can not secure for itself a sound experimental basis is, of course, of only ephemeral value.

These, then, are the steps which have led to our present standpoint in organic chem-

* *Ann. d. Chem.* (Liebig), **22**, 143.

istry: The discovery of isomerism, the discovery of radicals, the older radical theory, the theory of types, the establishment of true molecular weights, the discovery of the fact of valence, the determination of structure.

I think that all workers in organic chemistry will accept the following as a conservative statement of our present knowledge: (1) That in organic compounds, at least, each atom is attached *directly* to only a limited, small number of other atoms; (2) that in the sense of the order of the successive direct attachments the structure of a very large number of compounds is known with a degree of probability that amounts to practical certainty.

This brings me to the task which has been set, an attempt to outline the problems which lie before us in the further development of our science.

In the first place, there is still much to be done to extend our knowledge of compounds found in nature. This field is much less cultivated, relatively, than was the case sixty years ago. There has been good reason for this because of the problems of absorbing interest which have arisen in the preparation and study of new compounds and in the extension of our knowledge of old ones. But there must still remain many compounds to discover among both animal and vegetable products. On this side organic chemistry resembles the descriptive sciences of botany, zoology and mineralogy. And just as botanists think it worth their while to secure as complete a description as possible of the plants to be found on the earth, so it lies in our province to isolate and identify the carbon compounds of the animal and vegetable worlds—with the difference that in our case each compound, new or old, may be the starting point for the preparation of an almost endless number of others. But here most of us recognize that unless a compound has some further interest than that it is new it is not worth the time taken in its preparation. I am afraid, however, as we look over the pages of our journals, there is too much evidence that not every one lives up to this view. Our ever-increasing army of nascent doctors must needs have something to do, and it is so easy to make new compounds and so difficult to find something new of larger scope and really worth the doing.

There still remains much to do in the determination of the structure of compounds which have long been known. The study of a single compound often involves an incredible amount of work. Baeyer worked with indigo for fifteen years before his labors were crowned with a successful synthesis, and twenty years more and the work of very many chemists were needed before the scientific achievement could become a commercial success.

It was nearly twenty-five years after the first structural formula was proposed for camphor before Bredt was fortunate enough to suggest the true arrangement of its atoms, and it was ten years longer and required in all the work of more than fifty chemists before Bredt's suggestion was confirmed by Komppa's beautiful synthesis.

More than thirty formulæ were proposed for camphor, and those who think little of organic chemistry have some reason if they say that we jump at conclusions too hastily and propose too many formulæ that are mere guesses. Some might even say that the last formula isn't worth much, but those who have followed the matter know that step by step we have arrived at an almost positive certainty even in this complex problem.

The final solution of a problem with regard to the structure of a compound of natural origin is not usually considered to have been satisfactorily attained until its synthesis has been effected. Those who

have attempted work of this character know that months or even years of work are frequently spent to obtain the synthesis of a single compound. In spite of the wealth of methods at our command—a wealth so great that it is often very difficult to select between several which are equally unpromising—it is evident that these methods of synthesis need improvement at many points. Not only do we need new and better methods, but many old methods require further study to disclose why they succeed in some cases and fail in others and to secure a fuller knowledge of secondary reactions which often occur. As recent remarkable achievements in this field of synthetic methods may be mentioned the brilliant results obtained by Grignard with magnesium compounds, Bouveault's elegant new solution of the old problem of transforming an acid into the corresponding alcohol and Scheuble's reduction of the amides of bibasic acids to the corresponding glycols.

Work along the lines suggested needs to be done in order to fill out and complete our knowledge in a systematic way, and occasionally work along such lines is rewarded by results of epoch-making significance, as when Gomberg discovered triphenylmethyl in his endeavor to prepare hexaphenylethane. Such work is not likely, however, to greatly advance our insight into the real nature of carbon compounds and we all feel that there are far more fundamental problems which demand attention.

As outlined above, the theories of valence and of structure now universally accepted imply a certain amount of knowledge of the arrangement of atoms in space. So far as the original and fundamental conceptions are concerned, however, this knowledge is quite vague. The much more definite conception proposed by van't Hoff and in a somewhat different manner by Le Bel is, of course, familiar to you all. In discussing any hypothesis it is always important to have clearly before us the facts upon which it is based. As I have already hinted, I believe that the theory of valence and the theory of structure in the sense of a sequence of atoms within the molecule are supported by our knowledge of such a vast accumulation of consistently interrelated phenomena that we are justified in believing that we have positive knowledge with regard to the structure of the molecules of organic compounds. I am as ready as any one to demand that every theory, no matter how old or how universally accepted, shall be continually brought back to the test of agreement with experimental facts, but I am not willing to admit that we may not, in the end, acquire positive knowledge by the process of inductive reasoning.

Assuming, then, the fact of a knowledge of the sequence of atoms in organic compounds, we have this basis for van't Hoff's hypothesis: (1) When four unlike atoms or groups are combined with a single carbon atom optical activity results in such a manner that there may always be found two compounds having identical sequence of the atoms within the molecule, and exactly equal rotary power, but of opposite signs. (2) That when two adjacent carbon atoms are combined each with three unlike groups, two compounds may result which, while optically inactive and having the same sequence of atoms, still differ in physical properties. An illustration of this is found in racemic and mesotartaric acids. (3) Rings containing five and six atoms are formed with especial ease, those containing three, four and seven atoms less readily, and rings containing more than seven atoms are scarcely known. (4) Derivatives of cyclopropane, cyclobutane, cyclopentane and cyclohexane having two substituents combined with different car-

bon atoms often exist in two isomeric forms in which the sequence of the atoms is the same. (5) Derivatives of ethylene often exhibit a similar isomerism.

Assuming as true that we have acquired a knowledge of the sequence of atoms in carbon compounds, the facts which I have enumerated lead almost inevitably to the corollary that the four atoms attached to a given carbon atom are arranged in approximate symmetry around the center of that atom for their position of most stable equilibrium. The relation between this conclusion and the theory of the sequence of atoms in carbon compounds, or what is ordinarily understood as structure, is very similar to the relation between the atomic theory and Avogadro's law. If we accept the atomic theory, there seems to be no rational escape from the acceptance of Avogadro's law. In a similar manner, if we accept the theory of the sequence of atoms in carbon compounds, there seems no reasonable possibility other than that van't Hoff's hypothesis is true in its broad outlines.

I hope I may be pardoned here for a brief digression. I am aware that Franz Wald* believes that he can give a satisfactory explanation of the laws of fixed and multiple proportion and of combining weights without the aid of the atomic theory, and that Professor Ostwald in his recent Faraday lecture† has accepted and expanded the same thought. I will say frankly that their reasoning does not appear to me conclusive. Ostwald defines a chemical individual as 'a body which can form hylotropic phases within a finite range of temperature and pressure,'‡ and deduces from this the fact that a given hylotropic phase must have a fixed composition. He appears to forget that the existence of these hylotropic phases implies that the properties of matter are discontinuous, or, in other words, that there is a finite number of hylotropic bodies, one of the facts for which the atomic theory gives an explanation.

There is another characteristic, too, of a chemical compound which all chemists will agree is at least as important as that it shall consist of a 'hylotropic phase.' This is that the compound must not only have a fixed composition, but this composition must bear a definite relation to those numerical quantities which represent the proportion in which each element of which it is composed always combines with other elements. I need hardly add that these numerical quantities are so deeply seated in the properties of matter that, having adopted a unit, all chemists are absolutely agreed in selecting one and only one such quantity for each of the well-known elements.

In attempting to deduce this law of combining weights Ostwald assumes that three elements form the compounds *AB*, *AC*, *BC* and *ABC*, and adds, 'There shall be but one compound of every [each] kind.' With this assumption, his reasoning may be sound, but I fail to see how it applies when we find ten thousand compounds *ABC* instead of one. The case which he supposes is so far theoretical that I have been unable to find an actual case where the compound *ABC* can be formed, by the union both of *AB* with *C* and of *AC* with *B*.* But I have

* *Ztschr. Phys. Chem.*, **24**, 633, 1897.

† *J. Chem. Soc.* (London), **35**, 506.

‡ *Ibid.*, p. 515.

* It is quite possible that such an illustration may be found, but, in any case, Professor Ostwald's deduction can not be made to apply to those cases in which the compound *ABC* does not exist, nor to those cases where the compound *ABC* can not, even theoretically, be supposed to consist in turn of a known compound *AB* combined with *C* and of another known compound *AC* combined with *B*. Such cases are common because of the fact of valence. In its simplest form the law of combining weights is quite independent of the existence of the compound *ABC* and may be stated thus: If the com-

taken too much time with a matter which is aside from my main purpose. Before leaving this topic I must add, however, that I have used the phrase 'Avogadro's law' advisedly in spite of the fashion set by some chemists of calling it Avogadro's hypothesis.*

I remarked, a few moments ago, that the facts which have been outlined almost compel us to the acceptance of van't Hoff's hypothesis in some form. It is of the utmost importance for us to recognize, however, that we are here at the very confines of our present knowledge and that we must, at every step, bring ourselves back to the rigorous test of experimental fact. In accepting the hypothesis we are not compelled to consider molecules as set pieces of mechanism; on the contrary, there is strong reason for thinking that the positions assumed by the atoms are positions of dynamic and not of static equilibrium. While there have been many speculations in the matter, we have no strong reason for assuming, as yet, any definite shape for the carbon atom, nor even that there are within it definite points of attraction for other atoms. All that seems to be thoroughly established is that for their position of most stable equilibrium the four atoms or groups attached to a given carbon atom are arranged in approximate symmetry around its center. I say *approximate* symmetry because the existence of compounds containing rings of three and four carbon atoms demonstrates that the symmetry is not always absolute, and makes it probable that in cases where the four atoms or groups are unlike the symmetry is also imperfect. So far as I am aware, no fact inconsistent with this fundamental conception is known, while very many facts about optically active and cyclic compounds find in this conception the only satisfactory explanation which has thus far been given. It is true, also, that many facts with regard to optically active compounds indicate that when one group is exchanged for another the exact configuration is often retained, or, in other words, the entering group takes the same position with regard to the other three atoms or groups as was held by the group which was displaced. The manner in which it has been possible to work out, consistently, the complex relations between a considerable number of sugars, gives a very strong experimental basis for this statement. On the other hand, it is well known that such reactions often give racemic mixtures, which indicates that a shifting of groups with regard to a central carbon atom takes place much more easily than the shifting of a group from one carbon atom to another, at

position of two compounds *AB* and *BC* has been determined, the composition of a series of compounds between *A* and *C* can be predicted and a compound which does not belong to this series has never been discovered. A still more general statement of the law, and one which includes, by implication, all of those facts which are used in the selection of atomic weights, is given above. In that form it is more properly called the law of atomic weights.

* Two reasons may be given for this usage. My own view is that we have, by a process of inductive reasoning, acquired such positive knowledge of the existence of atoms and molecules that the expression 'Avogadro's law' is fully justified. But even if we admit the contention of those who think that the atomic theory must always remain an unproved hypothesis, it is possible to frame a definition of the word molecule which would be merely a generalized statement of those empirical facts which lie at the basis of our atomic and molecular theories. Such a generalized, empirical definition must, of course, be very complex but it would not include the concept of discrete particles. Yet it will be still true of these empirically defined molecules that equal volumes of gases contain equal numbers under the same conditions of temperature and pressure. For instance, the term gram-molecule may be considered as a purely empirical generalization and it is true that a gram-molecule of one gas occupies the same volume as a gram-molecule of any other. But this is, in essence, Avogadro's Law.

least in saturated compounds. There are also a number of extremely interesting cases where a reaction gives rise to the optical antipode. Thus Walden has shown* that l-chlorsuccinnic acid is converted by silver oxide into l-malic acid, while potassium hydroxide converts it into the dextrorotatory acid. It is evident that in one case or the other there has been a shifting of the groups. Again Ascham† has shown that when d-camphoric acid is heated with hydrochloric and acetic acids it may be about half converted into l-isocamphoric acid, and that the latter suffers a similar transformation. This case is more complicated, as a 'cis' and 'trans' isomerism of cyclic compounds is involved as well as the optical difference. Not many cases of this character are known, at present, but such cases certainly deserve further study and must be reckoned with in considering the question we have before us. Le Bel‡ has already pointed out the theoretical significance of Waldron's work.

While we may feel that we have comparatively sure ground in the application of the theory of van't Hoff and Le Bel to optically active and to cyclic compounds, the case is quite different when we come to the consideration of what are commonly known as 'double' and 'triple' unions. Professor Michael has done a very great service to chemistry in showing that the supposition of a more or less definite tetrahedral shape for the carbon atom and of 'favored' configurations often leads to conclusions which are at variance with the facts. Philips§ and Blanchard‖ and myself have found a case in which the addition of hydrobromic acid to an unsaturated compound produces an optically active body which evidently has the same configuration as the amino and hydroxy acids from which the unsaturated body is formed by the loss of ammonia or of water. We have here, apparently, a potential asymmetry occasioned by the double union which it is difficult to reconcile with the prevailing conception of such unions. This case is complicated by the presence of a second asymmetric carbon atom in the molecule and is worthy of further study. Rabe and Billmann* have recently described a similar case, but very few instances of this kind are known.

Pfeiffer† has recently suggested a new interpretation of van't Hoff's hypothesis as applied to unsaturated compounds. Pfeiffer assumes that unsaturated compounds retain essentially the same configuration as the saturated compounds, from which they are derived. On this side his interpretation is closely related to the old theory of free valences, which, if I understand him correctly, is favored by Professor Michael. Pfeiffer also brings his interpretation into a close relationship to Werner's theory of inorganic metallic compounds. The most serious objection to the theory is that it supposes the existence either of trivalent carbon atoms or of free valences, in ethylene and its derivatives, an objection which has appeared to most chemists very strong in the past. Pfeiffer points out, it is true, that since the discovery of triphenylmethyl we can no longer deny the possible existence of a trivalent carbon atom‡. It would

* *Ber. d. Chem. Ges.* **32**, 1855 (1899).
† *Ibid.*, **27**, 2004.
‡ *J. Chim. Phys.*, **2**, 344, 1904.
§ *Am. Chem. J.*, **24**, 428.
‖ *Ibid.*, **26**, 281; **27**, 428.

* *Ann. d. Chem.* (Liebig), **332**, 25.
† *Ztschr. Phys. Chem.*, **43**, 40.
‡ The fact that triphenylmethyl exists as a doubled molecule in solution should not, I think, lead us to discard the monomolecular formula for it any more than we consider that acetic acid has, in the ordinary sense of structure, a doubled molecule because it exists as a doubled molecule in solution in benzene or in the state of vapor just above its boiling point, nor because it forms acid salts. In these cases the chemical evidence ap-

seem, however, that the great difference between the intense chemical activity of triphenylmethyl and the comparative inactivity of ethylene demonstrates that, if the latter does in reality have free valences, the fact that there are two such valences reduces the activity of each enormously. The inactivity of carbon monoxide may be significant in this connection.

A more serious objection to Pfeiffer's hypothesis lies in the fact that he supposes so slight a difference in the configuration of fumaric and of racemic acids that it is difficult to see why the former as well as the latter might not be split into a pair of optically active bodies.

We must admit, then, that we have, at present, no satisfactory theory of double and triple unions and that we have here a problem which demands a large amount of further work before it is solved. When the solution is reached we shall probably gain a new insight into the perennial question of the structure of benzene, and our knowledge of tautomerism will cease to be, as it is at present, almost purely empirical. It is possible, perhaps probable, that Thiele's 'conjugated double unions' will contribute toward the solution.

While I have no comprehensive theory with regard to double unions to advance, I will, with a good deal of hesitation, venture to express some thoughts with regard to the combination of atoms in general which have some bearing on this question. We are all familiar with Faraday's law that if a current of electricity is passed through a number of cells filled with solutions of different electrolytes and arranged in series, exactly equivalent amounts of the various components will be liberated at the electrodes in the successive cells. The beautiful experiments of Professor T. W. Richards have demonstrated that we are dealing here with a law which is true for different solvents and over a wide range of temperature; and also that the law is true with a degree of absolute accuracy which is of the same order as the laws of the combination of elements by weight. We are compelled, then, to believe that there is associated with each valence of an ion as it is transported through a solution, or at least as it separates at an electrode, a quantity of electricity which is invariable and independent of the nature of the ion. In other words, we have here a natural electrical unit which can be defined in its relation to atomic weights with a degree of accuracy which seems to be limited only by the refinement of our manipulations.

It is not always recognized as clearly as it should be that this unit quantity of electricity which is associated with one valence of any ion is not a unit of electrical energy. If it were, the same energy would be required to decompose the equivalent quantity of one electrolyte as of every other, which is manifestly not true. While the same current causes the separation of equivalent quantities in the different cells, the differences of potential, and so the amounts of energy required for the separation, vary greatly. It is evident then that when we say that a unit quantity of electricity is associated with each valence of every ion we do not use the term *quantity* in the sense of quantity of electrical energy. Instead of this, when this conception of a unit quantity of electricity is examined it will be seen that it is a conception of something whose properties are those of matter rather than those of energy. The facts appear to be consistent with the idea that the unit quantity of electricity of which we are speaking is of a material nature and you have doubtless already perceived that

pears to be more important and more conclusive than the physical. It is probable that the doubled physical molecule is the result of forces which do not produce a stable structure in the ordinary sense.

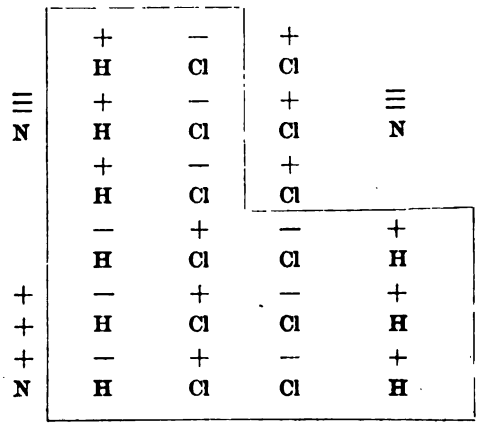
I have the theory of electrons in mind. The ingenious experiments of J. J. Thompson have given us considerable reason for thinking that the negative electrons are capable of an independent existence and have also given a probable estimate of their mass, which is small in comparison with the mass of the hydrogen atom.

It has been customary to think of the unit charge of electricity as being involved only in those reactions which occur in solution. If, however, we accept the theory of electrons it is evident that the electrons must be present in the molecule of an electrolyte no matter in what manner it is formed. It is but a step further to the conclusion that the electrons are involved in every combination or separation of atoms and, indeed, may be the chief factor in chemical combination.

Professor Kahlenberg* has shown that a practically instantaneous reaction takes place between hydrochloric acid and copper oleate in a solution in dry benzene, although the solution does not conduct an electric current and there is no evidence of the dissociation of either the copper oleate or of the hydrochloric acid. Professor Kahlenberg points out very justly that there is no apparent difference between these reactions and those which take place in aqueous solutions, where we have much independent evidence of the existence of ions. He draws the conclusion that no ions exist in either case. It would seem that we are equally justified in supposing that a substance not already in the form of ions may separate into them under the influence of a second substance with which it can react.

Some time ago Mr. Lyon and myself† showed that the primary reaction between chlorine and ammonia gives nitrogen trichloride, nitrogen and hydrochloric acid, and that these products are formed in such proportion as to lead to the conclusion that three molecules of ammonia react simultaneously with six molecules of chlorine. It was pointed out at the time that the simplest explanation of this result is to be found in supposing that chlorine atoms separate during the reaction into positive and negative ions, while the ammonia separates partly into positive nitrogen and negative hydrogen and partly into negative nitrogen and positive hydrogen.* This hypothesis has met with some approval,† but has also received the criticism that such a dissociation as is supposed would result in the spontaneous decomposition of ammonia into nitrogen and hydrogen.‡ This criticism loses its force if we suppose that the separation into ions takes place only under the immediate influence of the chlorine with which the ammonia reacts. It has been pointed out by many different authors§ that a separation of atoms from each other must occur either before or at the same time that they enter into combination with other atoms. The only part essentially new in the hypothesis proposed is that this separa-

* This was represented graphically thus:



* *J. Phys. Chem.*, **6**, 1.

† *J. Am. Chem. Soc.*, **23**, 460.

† Stuglitz, *J. Chem. Soc.*, **23**, 707.

‡ *Ztschr. Phys. Chem.*, **41**, 378.

§ See Erlenmeyer, Jr., *Ann. Chem.* (Liebig), **316**, 50.

tion is into positive and negative parts and that the same atom may be sometimes positive and sometimes negative. The idea of a dissociation which occurs under the influence of a reacting substance appears to be implied in a part of Professor Nef's discussion of methylene dissociation, but it is not always clear whether he has in mind chiefly a dissociation of this sort or one which is independent of the interaction of different compounds.

The thought that the same atom may be at one time positive and at another time negative is related to the older electrochemical theory which supposed water to be positive in acids and negative in bases.

We assume, then, that in every combination of atoms each union involves an attraction between the positive and negative electrons which are associated with the two atoms that unite. In saying this I do not lose sight of the fact that such a thing as attraction *per se* in the sense that one body can influence another at a distance without an intervening medium is, apparently, inconceivable. I think of the attraction as probably caused by some motion of the electrons which enables them to act on each other through the aid of the ether. It is convenient, however, to speak of this effect as an attraction, since our conception of its real nature is, of necessity, very vague. One advantage of the idea that the attraction of the electrons is of a kinetic nature is that we may conceive of the same electron as becoming positive or negative, according to the nature of its motion.

The common conception, at present, is that an atom which has lost an electron becomes positive, while either the electron in its independent existence or the atom to which it is attached becomes negative. So far as I am aware, it has not been pointed out that this view leads to the conclusion that the same atom must, under different conditions, have a different weight. Thus a bivalent copper atom which has lost two electrons must weigh less than a univalent copper atom, which has lost only a single electron. It is true that our methods of determining atomic weights are scarcely accurate enough to detect differences of this order. The suggestion which is made is that the electrons of two atoms which are united have motions which correspond to positive and negative charges, respectively, and that when the atoms separate these motions may be retained, or lost, as in the case of a mercury atom which is uncombined, or that the motions may be reversed. In accordance with the hypothesis outlined above, we must assume that when two atoms separate either one may become positive; dependent partly on their nature, partly on the nature of the reacting substance. The conception here proposed is that of something very similar to the action of the pole of a magnet, which may attract another pole of the opposite kind, or induce the formation of a pole of the opposite kind, or it may reverse the polarity of another magnet.* This is, perhaps, simpler than to suppose the transfer of an electron from one atom to another in those cases where the electrical charges of the atoms are reversed in the ionization. A very accurate determination of the atomic weight of cupric copper as compared with that of cuprous copper might possibly decide between the two hypotheses.

It should be noted that the hypothesis that the electrical charges associated with the atoms are of a kinetic nature, and that these charges may be transferred without gain or loss of matter, is quite independent of the first hypothesis, which is that the

* This is, of course, only an analogy and must not be pressed too far; just as the electrical changes of atoms or ions conduct themselves very differently from those of masses. The latter divide themselves between two bodies in contact; the former may be transferred *completely* from one ion to another.

atoms are ionized when they separate from each other and that the same atom may become either positive or negative.

In following farther the thought of the attraction between electrons as the cause of chemical combination, we must suppose that in addition to the effect of this attraction in holding together the atoms which are immediately attached there is a residual effect upon other atoms within the molecule. This gives a rational explanation of the very great difference in the stability of the union between carbon atoms in different compounds as, for instance, the instability of acetacetic acid in comparison with butyric acid, occasioned by the substitution of an oxygen atom for two hydrogen atoms of the latter. The study of organic compounds has given us a knowledge of a large number of cases of this sort and our text-books contain many empirical rules about them, but there have been few, if any, attempts to give for such facts any rational explanation.

In considering double unions three explanations suggest themselves: (1) We may suppose with Pfeiffer that such unions are in reality single unions and free valences. In this case the presence in adjacent carbon atoms of positive and negative electrons which are uncombined would reduce the attraction of each for the electrons of another molecule, thus explaining why two free valences are so much less active than a single one. (2) We may suppose that the carbon atoms are in reality doubly united, but that, owing to the localization of the electrons in definite parts of the carbon atoms, the four electrons involved can not approach as near to each other as is the case in a single union. This is Baeyer's theory of strain and is much better in accord than is the theory of free valences with the fact that cyclopropane and propylene appear to be about equally unsaturated as evidenced by their heats of combustion and by their conduct toward bromine. On the other hand, it seems to lead logically to conclusions with regard to the addition of bromine to triple unions which Professor Michael has shown are contrary to the facts. (3) Without a condition of strain, we may suppose that the presence of both a positive and a negative electron in each of the atoms united by the double union causes a lessening of the attraction of the electrons. This would result in such a union being less stable than a single union. The second and third views appear, at present, most in accord with the facts—possibly the truth lies in some combination of the two.

Whatever view we may take, it is noteworthy that double unions are usually formed by the loss of a positive and negative atom or group from adjacent carbon atoms, as hydrogen and hydroxyl or hydrogen and bromine. It is also true that in many double unions one of the carbon atoms is more positive than the other, causing the addition of halogen acids in a definite manner which may be predicted in accordance with Michael's 'positive negative law.' Applying this thought to conjugated double unions, we see that of the four atoms involved the two central ones are likely to be positive and negative respectively and neutralize each other's attraction for outside atoms, while an intensified attraction for outside atoms would be found in the exterior atoms. The effect may be analogous to that of the attractive forces of a magnet which exhibit themselves chiefly at the ends.

But I have permitted myself to wander much farther in the field of speculation than was my first intention—farther than is at all profitable, I fear, for these questions furnish, at present, few points for experimental study, and speculations divorced from experiment have usually been profitless. I should be very sorry if what

has been said should give encouragement to such speculations. On the other hand, I have a very firm conviction that we should not be content with rounding out organic chemistry as a descriptive science nor even with adding to the number of empirical rules which enable us to predict certain classes of phenomena. We must, instead, place before ourselves the much higher ideal of gaining a clear insight into the nature of atoms and molecules and of the forces or motions which are the real reason for the phenomena which we study. When we consider the progress which has been made and the knowledge of structure we now possess, which would have appeared sixty years ago to lie beyond the limits of possible acquirement, it is not presumptuous to think that a more complete knowledge of these questions will at some time be gained. This fuller knowledge will take account, too, of many lines of work upon which I have no time to dwell, such as the question of changing atomic volume to which Professors Richards and Traube have directed our attention, and the knowledge of heats of combustion, of molecular refraction and dispersion, of color, viscosity, dielectric constants and other physical properties. The future must give to us a new theory or a development of old ones which shall include all of these phenomena in one comprehensive view.

WILLIAM A. NOYES.
U. S. BUREAU OF STANDARDS.

SCIENTIFIC BOOKS.

MUSEUMS AND MUSEUM APPLIANCES.

The Museum. By L. P. GRATACAP. Reprinted from the *Journal of Applied Microscopy and Laboratory Methods*, Vols. V. and VI.

Bericht über einige Neue Einrichtungen des Königlichen Zoologischen und Anthropologisch-Ethnographischen Museums in Dresden. Von Dr. A. B. MEYER. 4to. Pp. 25; pls. I.–XX.

The first of these is a reprint of Mr. Gratacap's series of papers which appeared in the *Journal of Applied Microscopy* and is a pamphlet of about 100 pages with many illustrations. In book form it would make a good-sized volume and as these articles contain a good résumé of the principles of museum construction and methods of installation, it is a pity that they could not have been issued in such shape. Mr. Gratacap is well qualified to treat of museum matters, and since there is not space to note all the good things he says, it must suffice to discuss a few concerning which there may be room for a difference of opinion. The first is to be found almost at the beginning, where Mr. Gratacap makes a plea for a uniform system in museum methods. The field covered by museums is so vast and the educational features at present so little developed that there is ample scope for diversity in the treatment of museum exhibits, the more that those features that are universally good can only be ascertained by experiment, to say nothing of the fact that the ends sought for may be very different in different museums. To illustrate this we may consider the questions of the display of skeletons and of fossil vertebrates. If the aim is to show the structure and relationship of vertebrates as a whole the two should be combined, the number of specimens should be limited, and fragmentary fossils almost entirely excluded, this being a case where a cast or good drawing is much better than an imperfect specimen, since it is necessary to compare animals in their entirety. If the object is to show the succession of life on the globe, then the fossils should be arranged zoologically under their respective geological periods, so that the visitor can see the successive steps by which the present fauna of the globe has been reached. Still a third arrangement of fossil vertebrates is possible, that adopted by Professor Osborn, of showing by numerous specimens the phylogeny of various groups. If it is desired to show the structure and characters of vertebrates, then skeletons and other anatomical preparations may be placed with mounted animals. No one museum can do all these things and each institution must decide on the plan that best suits its circumstances.

Mr. Gratacap considers the plan and structure of museum buildings, touching particularly on their lighting, and devotes considerable space to case construction, important matters concerning which architects as a rule display lamentable lack of knowledge. It is possible that an architect may, unaided, have designed a good museum case, but if so the reviewer is not aware of the fact, architects' cases being clumsy, poor as to light, and calculated to catch the dust. As to the lighting, it may be said that plate glass should never be used in the windows of museums, but ground glass or luxfer prisms. It is impossible to control the sunlight by the use of curtains and in almost any museum one may at times see the sunlight pouring in and ruining valuable specimens. Diffused light is not only better for the specimens, but better for visitors. Again, windows should not reach to the floor, but be well above it, not merely to give wall space, but because experiment has shown that the best light comes from above, the upper third of a window equalling the lower two thirds in illuminating power. Windows in museums are for the purpose of admitting light, not for giving a view of the surrounding country. Also each window should be fixed so that it may not be opened for the admission of dust and smoke; it is time that museums were ventilated on scientific principles (a few are) and not after the manner of a wigwam. And in the present day of electric lighting it should be an easy matter to overcome the difficulty of dark corners. This leads one to say that it will not be long before more attention is given to lighting exhibition cases from the inside, where the objects displayed can be well illuminated and the exasperating shadows attendant to external lighting avoided. Mr. Ward, of the Milwaukee Museum, has secured extremely good results in this direction, and it has also been used in the large Bass Rock group in the Ipswich Museum, England. Still a word or two more concerning cases, which are treated in considerable detail and are objects about which Mr. Gratacap's wide experience enables him to judge of what should be adopted and what avoided, but it may be added that seven feet is high enough for the average museum case; most large mammals may be accommodated in a case nine feet high and anything over that height is for groups or special exhibits.

The sliding partition, which Mr. Gratacap views with distrust, is neither awkward nor unnecessary, and in the U. S. National Museum the idea has been further elaborated by having the entire bottom of a case running on trunk rollers, and removable. These devices permit the use of large, fixed plate glass panes for the sides of cases and restrict the movable sash to the minimum. A case can not be made that is at once dust-tight and easy of access, and as exhibits are only changed at intervals some concessions may be made. Brackets, pedestals, mountings and labels, each and all claim attention, but the use of many of these depends on the amount of money or size of the working force available. The poor curator may be forced to hang specimens from wires instead of using elaborately finished brass fittings, but, after all, there is a great deal of installation that might be improved with a little thought and care. The average museum errs on the side of endeavoring to show too much; ten good specimens well displayed are worth one hundred badly installed.

Turning now to Dr. Meyer's memoir, which follows the lines of one published about ten years ago, one notes many improvements in cases and methods of installation which Dr. Meyer has found time to devise. He is an ardent advocate of iron cases and, if we remember aright, was the first to work out the details of their construction and bring them into use on any extensive scale.

In the United States he has been followed by Dr. Jayne and Dr. Greenman, of the Wistar Institute, where a plant has been installed for the manufacture of cases for that institution. In the matters of lightness of construction, resistance to changes of climate and safety from fire the iron case is indubitably far in advance of any other. Nevertheless, it has certain drawbacks, including cost and time of construction and, with all due deference to Dr. Meyer, appearance. Pri-

marily a case is for the preservation of specimens, but secondarily it plays an important part in furnishing a museum and this fact should not be lost sight of. A series of huge glass boxes does not form an attractive sight, and at the Wistar Institute it was found necessary to provide the cases with a cornice to mitigate the bareness of their appearance. This criticism applies also to the all-glass case, with the additional remark that we have not yet seen a large glass case through whose joints it was not possible to slip a card.

For storage, library and office use and for purely practical purposes the iron case has no equal, and it is to be hoped that the time may soon come when such cases can be made at a reasonable price and in a reasonable time. From the variety of design shown in Dr. Meyer's paper it would seem that the above conditions have been satisfactorily met in Germany, or broadly speaking, in Europe, for iron cases have been extensively adopted during the past decade. Dr. Meyer gives various views and plans for floor and desk cases, storage cases for insects and eggs, catalogue cases, and bookcases in which a vertical row of shelves may be withdrawn when books are needed or closed flush when not in use. Incidentally Dr. Meyer calls attention to the good results obtained by the use of dyed sawdust as a medium in which to arrange eggs, since this affords a good background and at the same time holds the eggs in any desired place. Naturally it is necessary to be sure that nothing in the dye will affect the eggs. Turnstiles, adjustable trucks for moving cases, swing screens, mountings for skulls and skeletons, are among the things figured and described, all bearing testimony to the thought and time Dr. Meyer has given the subject of museum furniture. F. A. L.

Madreporaria. Parts I. and II. By J. STANLEY GARDINER, M.A. (From 'The Fauna and Geography of the Maldive and Laccadive Archipelagoes,' Vol. II., Part 3, pp. 755–790, Pls. LIX. to LXIV.)

This, the first instalment of Mr. Gardiner's report on the Madreporaria collected by the expedition under his charge to the Maldive and Laccadive archipelagoes, contains: (1) Introduction with notes on variation, (2) the Astræidæ.

I. *Introduction with Notes on Variation.*—The collection contains over 1,000 specimens of dried corals besides a large number in spirit and formalin and a quantity of smaller pieces for comparative purposes. The collections were obtained mainly from (*a*) Minikoi, the most southern bank of the Laccadive Group; (*b*) Goidu, the east island of Goifurfehendu atoll; and (*c*) Hulule, the most southeasterly island of N. Male atoll. An attempt was made to collect as thoroughly as possible—particularly at Minikoi and Hulule—for the comparison of the localities with one another, and specimens were not generally taken from reefs elsewhere. In addition, dredgings yielded a considerable number of specimens, although few hauls were taken on the outer slopes of the reefs.

Mr. Gardiner made a series of observations in order to ascertain how far mode of growth is dependent on light and environmental conditions and had intended to publish these observations, but thinking that the subject had only a limited interest and because of the cost of suitable illustrations, he did not give his observations in full, merely indicating as briefly as possible under each species the variation found in the several colonies due to these causes. It is very much to be regretted that Mr. Gardiner did not present in full the data that he had accumulated on this subject. It is very doubtful if we shall ever obtain a real insight into what constitutes species in corals without studies of the kind which Mr. Gardiner apparently made and without a full presentation of such data. Quite likely considerable experimental work will be necessary in order to ascertain more definitely the influence of certain environmental conditions, such as experiments in planting the young from the same parent colony in different localities where the conditions of growth are different, and observing the resultant growth forms.

Mr. Gardiner divides the variation shown by corals into three classes: (*a*) *Vegetative,* that is the variation that is due to environmental conditions. (*b*) *Continuous,* where a

series from one locality grades into a series from another locality; this kind of variation is exceedingly complex and almost impossible to distinguish from the vegetative. (*c*) *Discontinuous* or *specific* variation. The author says a species in one locality may show *discontinuous* variations in one or more characters, but it by no means follows that the same discontinuous variations will be shown by the same species in a different locality. Work on a collection from a single locality is best calculated to bring out the phenomenon, but one requires a collection from some other locality for comparison.

II. *Astræidæ*.—About 400 of the specimens collected belong to this family. They are divided into 69 species and 21 genera. The author obtained in the Pacific only 12 genera, and Klunzinger obtained from the Red Sea 16 genera (omitting synonyms). This shows that in the Maldive and Laccadive archipelagoes this group of corals is quite rich in both species and genera. In the arrangement of the genera Duncan's classification is followed, and the author correctly says this work is in need of thorough revision.

The following is a list of the genera with the number of species referred to each, and the names of the forms considered new:

Antillia, 1, *A. constricta* Brug., var. *maldivensis* nov.; *Cylicia*, 1; *Tridacophyllia*, 1; *Euphyllia*, 2; ? *Mycetophyllia*, 1; *Mussa*, 1; *Symphyllia*, 1; *Cœloria*, 6, *C. cooperi*, nov., *C. magna*, nov.; *Leptoria*, 1; *Hydnophora*, 4, *H. grandis*, nov., *H. maldivensis*, nov.; *Favia*, 10, *F. adduensis*, nov., *F. laccadivica*, nov., *F. hululensis*, nov., *F. parvimurata*, nov.; *Goniastræa*, 4; *Aphrastræa*, 1; *Orbicella*, 8, *O. minikoiensis*, nov., *O. borradailei*, nov.; *Cyphastræa*, 6; *C. suvadivæ*, nov., *C. maldivensis*, nov.; *Echinopora*, 4; *E. tertia*, nov., *E. magna*, nov.; *Galaxea*, 5; *Stephanocœnia*, 1, *S. maldivensis*, n. sp.; *Acanthastræa*, 1, 2 vars.; *Prionastræa*, 7, *P. suvadivæ*, nov.; *Merulina*, 2.

The reviewer thinks that it is to be regretted that Mr. Gardiner followed the classification of Duncan. Since the publication of the latter author's 'Revision of the Families and Genera of the Madreporaria,' considerable progress has been made in the classification of the Madreporaria and in the correction of the nomenclature. The family name Astræidæ can not be used in corals because no genus of corals can bear that name. A discussion of the name *Astrea* or *Astræa* will be found in the reviewer's 'Eocene and Lower Oligocene Coral Faunas of the United States.'* It has been known for some time that the genera referred to this family by Milne Edwards and Haime would have to be distributed in quite a number of families. Attempts at reclassification have been made by Verrill, Koby, Ogilvie-Gordon, Gregory, Felix and the reviewer. Morphologic proof of the correctness of some of these attempts has recently been published by Professor Duerden in his 'Recent Results on the Morphology and Development of Coral Polyps.'† It seems that it would have been preferable for Mr. Gardiner to have utilized this literature and arranged his specimens more or less in accord with the suggestions contained there; but it must be admitted that the results so far obtained are not always definite, and Mr. Gardiner would have been obliged to supplement by his own work these attempts at reclassification. Knowing the present status of the problem, he evidently preferred following the system of Duncan although he knew it was faulty.

Several of the generic names used by Mr. Gardiner will have to be changed. The name *Tridacophyllia*, de Blainville, should become *Pectinia* Oken.‡ According to Professor Verrill§ the genera *Mussa* and *Symphyllia* must be combined. The genus *Cœloria* is considered separate from *Mœandrina* M. E. & H. (not *Meandrina* Lamarck, 1801). Both Professor Verrill and the reviewer believe that the species hitherto divided into those two genera should be combined into one. This

* 'Monograph U. S. Geological Survey,' Vol. XXXIX., p. 154, 1900.

† 'Smithsonian Miscell. Coll. Quart. Issue,' Vol. XLVII., pp. 93–111, 1904.

‡ Vaughan, 'Some Fossil Corals from the Elevated Reefs of Curacao, Arube and Bonaire,' *Samml. Geolog. Reichs.-Mus. Leiden*, ser. ii., Bd. II., p. 15, 1901.

§ *Trans. Conn. Acad. Sci.*, Vol. XI., p. 177, 1902.

point can scarcely be discussed here, but examinations of large suites of material have convinced the reviewer that the criteria used by Mr. Gardiner for their differentiation are not valid. That is, he says, '*Cœloria* has a true columella, whereas *Mœandrina* has merely trabeculæ extended out from the septa to fill up the axial fossa.' The generic name *Hydnophora* was originally proposed by Fischer v. Waldheim, 1807, for a genus of Paleozoic corals and can not be used for the recent corals to which the name was applied by Milne Edwards and Haime.* *Monticularia* Lamarck, 1816, is available for the *Hydnophora* of Milne Edwards and Haime.

Mr. Gardiner spells such names as *Goniastræa* with the diphthong 'æ.' The original spelling of these names by Milne Edwards and Haime† is with an 'e,' but in their 'Histoire Naturelle des Coralliaires' they change the 'e's' to diphthongs, 'æ's.' The reviewer is of the opinion that the original spelling should be followed instead of the innovation of 1857. The genus *Prionastræa* M. E. and H., should be changed to *Favites* Link.‡

The two criticisms made on Mr. Gardiner's memoir are: (1) He should not have suppressed any data that he possessed regarding the influence of environment on variation. (2) It is regrettable that he has not utilized, and incorporated in his work, recent studies on the classification of the genera treated in his paper, and that his nomenclature is often faulty. However, Mr. Gardiner has given us some of the data regarding environmental influence on variation and his work is thoroughly comprehensible even if he has not utilized modern investigation on the reclassification of these corals. His memoir is decidedly the best contribution that has been made to the so-called 'Astræid' corals of any one area in the Indian Ocean, and its value is very much enhanced by six excellently executed half-tone plates which illustrate 32 out of the 69 species discussed. The criticisms made above may be regarded merely as suggestions for consideration in future work.

T. WAYLAND VAUGHAN.

SMITHSONIAN INSTITUTION,
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* Trautschold, 'Die Kalkbrüche von Mjatschkowa,' *Nouv. Mém. Soc. Imp. Natur. de Moscou*, t. xiv., p. 38, 1879.

† *Comptes Rend.*, Vol. XXVII., 1848.

‡ Vaughan, 'Fossil Corals from the Elevated Reefs, Curacao, etc.,' p. 21, 1901. Verrill, *Trans. Conn. Acad. Sci.*, Vol. XI., p. 89, 1902.

SCIENTIFIC JOURNALS AND ARTICLES.

THE contents of the October number of the *American Chemical Journal* are as follows:

Contributions from the Chemical Laboratory of Harvard College: 'On Certain Derivatives of the 1,3,5-Triiod-2,4-dinitrobenzol,' by C. Loring Jackson and J. F. Langmaid; 'The Existence of Hydrates in Solutions of Certain Non-Electrolytes and the Non-Existence of Hydrates in Solutions of Organic Acids,' by Harry C. Jones and Frederick H. Getman; 'The Existence of Alcoholates in Solutions of Certain Electrolytes in Alcohol,' by Harry C. Jones and Frederick H. Getman. Contributions from the Sheffield Laboratory of Yale University: CXIX., 'Researches on Pyrimidines: 2-Oxy-4,6-diaminopyrimidine,' by Henry L. Wheeler and George S. Jamieson,' CXX., 'On the Action of Phenylhydrazine on Benzoylpseudoureas: 1,5-Diphenyl-3-aminopyrro-α,β'-diazole Derivatives,' by Treat B. Johnson and George A. Menge'; 'On the Fate of Potassium Myronate in the Animal Organism and Its Hydrolysis by the Ferments of the Liver,' by J. H. Kastle and Eloise Chesley McCaw; 'On the Oxidation of Sulphocyanic Acid and Its Salts by Hydrogen Peroxide,' by J. H. Kastle and Claude Robert Smith. Contributions from the Chemical Laboratory of the Nebraska Wesleyan University: VII., 'The Preparation of Aromatic Nitroso Compounds,' by Frederick J. Alway; VIII., 'The Nitrosocinnamic Acids and Esters,' by Frederick J. Alway and Walter D. Bonner; IX., 'On Certain Nitrogen Compounds,' by Frederick J. Alway and Reuben M. Pinckney; X., 'The Molecular Weights of the Yellow Nitroso Compounds,' by Frederick J. Alway and Ross A. Gortner. Reviews.

The Popular Science Monthly for October may be termed a British Association number, being devoted to the addresses delivered at the last meeting by the presidents of various sections. It opens with 'A Traveler's View of the British Association Meeting,' very pleasantly presented by Henry S. Pritchett and illustrated with views of many of the more noteworthy buildings in Cambridge. Fol-

lowing this are 'Reflections suggested by the New Theory of Matter,' by Arthur James Balfour; a discussion of 'The Mathematical Physics of the Nineteenth Century,' by Horace Lamb; 'Heredity and Evolution,' by William Bateson; 'The Perception of the Force of Gravity by Plants,' by Francis Darwin; 'The Ethnological Work of Lane Fox,' by Henry Balfour; 'On Mountains and Mankind,' by Douglas W. Freshfield; 'Correlation of Reflexes and the Principle of the Common Path,' by C. S. Sherrington; and 'Invention and Discovery,' by Charles A. Parsons. The number contains the index to Vol. LXV.

Bird Lore, for September-October, contains articles on 'President Roosevelt and Bird Protection'; 'A Woodcock at Home,' by E. G. Tabor; 'October Bird Music,' by Earle Stafford; 'King Cole, a Biography,' by Susan M. Morse; the sixth paper on 'The Migration of Warblers,' by W. W. Cooke, and the 'Climatic Variation in Color and Size of Song Sparrows,' by Frank M. Chapman. There are also book reviews and notes, the Audubon Department and an educational leaflet on the 'Screech Owl,' by William Dutcher.

Beginning in January next, a new educational journal, entitled 'The Nature Study Review,' will be published bi-monthly with Dr. M. A. Bigelow, adjunct professor of biology at Teachers College, Columbia University, as managing editor.

DISCUSSION AND CORRESPONDENCE.

THE METRIC SYSTEM.

To the Editor of Science: I wish to object to a statement recently made with regard to the use of old names in countries that have accepted the metric system. It has been said that the common people in continental Europe are not yet fully accustomed to the metric system, and have partly retained the old names in preference to the new ones.

This is absolutely untrue, as far as it refers to Germany. After the official introduction of the metric system in that country, it took a very short time—if not a fortnight, certainly only a few months—to make the 'masses' familiar with it, and about a year after its introduction there was nobody but a few old and decrepit people that had been unable to master it. In fact, there was general rejoicing on account of the riddance from the old and cumbersome system. Indeed, a few of the old words are occasionally used in Germany, but only such that come very close to a metric unit ('Pfund,' 'Maass'), and these are always used in the metric sense, and nobody wants to imply by this that he is opposed to the metric system, or that he is unable to grasp it: it is merely a variety of speech, and distinctly individual or local.

The whole discussion of the metric system carried on recently in Science has been very amusing to the writer, and has furnished stuff for merriment to others. Is it actually the case that the opponents of the metric system believe that the American people are incapable of accomplishing the identical thing that has been done in Germany thirty years ago in a surprisingly short time? Is it actually impossible to obtain correct information about the way it was done there, and about the consequences and incidents connected with this change?

A. E. Ortmann.

Pittsburgh, Pa.

SPECIAL ARTICLES.

IS MATTER TO BE ABOLISHED?

Of late we have been hearing many intimations that matter has had its day. Formerly matter and its properties engaged the attention of the physicist. Later the ether was discovered, and now we are told that the ether and electrons are all that will be left, when the new discoveries have been fully digested. In connection with these statements I wish to lay down a few propositions which may have been overlooked.

It does not appear that electricity has ever been separated from something that has mass.

The propositions that matter has mass, and that a mass of matter has inertia, seem to me to be fundamentally different from each other.

If the inertia of matter can be accounted for as an electromagnetic phenomenon, it may be measured in new units. Instead of being merely a mass phenomenon, it may be referred

to the fundamental units in which all electromagnetic quantities are measured, *i. e.*, the units of mass, length and time.

Formerly the unit of force was referred to the unit of mass only. People talked about a pound of force. Later it was discovered that a force could also be measured in terms of the centimeter, the gram and the second. When that step was taken there was no talk about matter being abolished. Perhaps the present idea is due to the behavior of radium and uranium. When an 'atom' explodes, and exhibits qualities which entitle a few substances to be considered as cranks among substances, we have been thrown off our guard for a moment. We have had all sorts of explosives before. Some of them exploded so slowly that we did not call them explosives at all. When certain crystallized salts lose their form, due to the slow emission of the same emanation that is given off by all animals and plants, we were not greatly disturbed. Nitro-glycerin has long been going to pieces, and giving off more energy per gram per second than any radio-active body yields. But when it was found that these radio-active bodies are going to pieces, and giving off more energy per gram than any other body has been known to give before, we seem to have been induced to suspect all matter of being capable of doing so.

An architect who should learn that the bricks with which he is familiar are not the final elements in his structure would hardly be justified in losing his respect for houses. What does it matter that his bricks contain molecules, which are composed of atoms, which are composed of electrons, and perhaps something else? Does the fact that houses have been known to fall to pieces and give off energy change his estimate of those houses which do not fall? Is he justified in supposing that all houses are really falling, and that their motion will become appreciable if we wait long enough to make the motion so large that we can see it? FRANCIS E. NIPHER.

CURRENT NOTES ON METEOROLOGY.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

AMONG the most important matters referred to in the administrative portion of the report of the chief of the weather bureau for 1902–3 are the following: In place of the small chalk-plate weather map (11 x 16 ins.), now issued from twenty-three of the weather bureau stations, larger maps (22 x 16 ins.), prepared in the same way, are to be used, if the necessary additional appropriation can be secured. Professor F. H. Bigelow is continuing his studies on the general circulation of the atmosphere and the nature of cyclones and anticyclones, believing that his results 'point unmistakably to a theory which will supersede those heretofore published in meteorological literature.' One of the most important steps which have been taken in the history of the weather bureau is the plan to build up a great center of meteorological research at Mount Weather, on the crest of the Blue Ridge Mountains, about six miles from Bluemont, Va., and the work which it is proposed to do there will, if the plan can be fully carried out, lead to valuable results. Among the investigations which are announced as likely to be undertaken are the exploration of the upper air by means of kites and balloons, the study of numerous problems in solar physics, observations in electricity and magnetism, etc. A new seismograph has been procured and installed in Washington.

MONTHLY WEATHER REVIEW.

The Monthly Weather Review, for May, 1904 (dated July 22), contains the following articles of general interest: 'The Circulation in Cyclones and Anticyclones with Precepts for Forecasting by Auxiliary Charts on the 3,500-foot and the 10,000-foot Planes,' by Professor Frank H. Bigelow; 'The Sensation of Discomfort,' by W. F. Tyler; 'The Promotion of Meteorology,' in which is incorporated a letter from Dr. J. M. Pernter, of Vienna, in regard to a bill introduced into the last congress 'to promote further discovery and research in meteorology'; 'Invariability of our Winter Climate,' by W. B. Stockman. Also the following notes: 'Local Cooperation in Frost Prevention,' 'The Meteorology of Jamaica,' and 'Humming of Telegraph Wires and Poles.' The *Review* also announces the

establishment of a meteorological laboratory at the high school in Chattanooga, Tenn., a citizen, whose name is not given, having provided the means for the purchase of the necessary meteorological apparatus.

GERMAN METEOROLOGICAL SOCIETY.

THE tenth meeting of the Deutsche Meteorologische Gesellschaft was held in Berlin, on April 7–9, 1904, and an account of the proceedings, with abstracts of the papers read, is found in the July number of the *Meteorologische Zeitschrift*. The papers of most general interest were the following: The influence of forests upon climate, by J. Schubert, in which the results obtained recently at the forest experiment station in Eberswalde, Prussia, were discussed. The temperature is found to average lower in the forest than in the open, the maximum cooling effect coming in September, at the 8 A.M. observation. The relative humidity in the forest may exceed that in the open by seven per cent. O. Steffens showed a new form of snow gauge ('ombrograph') in which an oil lamp is included and the snow is melted. P. Polis discussed the distribution of precipitation in cyclones and anticyclones at Breslau and on the Schneekoppe, this being a scheme of investigation which might well be extended. W. Meinardus considered the changes in temperature of the ocean surface off the west coast of Europe, a subject to which he has already given much attention.

NOTES.

THE 1904 volume of the *Annuaire Météorologique* of the Royal Observatory of Belgium contains the usual meteorological summaries, together with the following papers of general interest: H. Arctowski: 'Aperçu des Résultats Météorologiques de l'Hivernage antarctique de la Belgica'; E. Vanderlinden: 'Le Tir contre la Grèle,' a subject which is rapidly assuming a less and less prominent place in the minds of scientific men. The latter paper contains a full bibliography.

The Yearbook of the Department of Agriculture for 1903 (Washington, 1904), contains the following contributions of meteorological interest: James Kenealy, 'Weather Bureau Stations and their Duties'; J. Warren Smith, 'Relation of Precipitation to Yield of Corn'; H. J. Cox, 'Use of Weather Bureau Records in Court.'

Weather Bureau Bulletin No. 34 (1904) is a reprint of an article on climate, written by the chief of the weather bureau for the 'Encyclopedia Americana.' The title is 'Climate: its Physical Basis and Controlling Factors.' In the bibliography one can not help noticing the omission of Hann's 'Handbuch der Klimatologie.'

Smithsonian Miscellaneous Collections, Quarterly Issue, Vol. 2, Part I., 1904, contains 'The Absorption of Water Vapor in the Infra-Red Solar Spectrum,' by F. E. Fowle, Jr.

R. DEC. WARD.

SCIENTIFIC NOTES AND NEWS.

A LARGE number of the eminent European scientific men and scholars, who came to this country to attend the International Congress of Arts and Science, at St. Louis, have been visiting eastern cities and universities. They were received at Washington by President Roosevelt and entertained by Professor Simon Newcomb, the president of the congress; at Cambridge, they were entertained by Professor Münsterberg, vice-president of the congress. Many of them have also visited Johns Hopkins, Pennsylvania, Princeton, Columbia, Yale and other institutions.

DOCTORATES of science have been conferred by the University of Leeds as follows: Lord Kelvin, Lord Rosse, chancellor of the University of Dublin, Sir Isaac Lowthian Bell, Sir James Kitson, M.P., Sir William Henry Broadbent, Sir Arthur W. Rücker, principal of London University, Dr. Thorpe, C.B., director of the government laboratories, Mr. Claudius G. Wheelhouse, LL.D., president of the council of the British Medical Association, Mr. Jonathan Hutchinson, Mr. J. Pridgin Teal, Dr. Hughlings Jackson, Professor Miall, Dr. Tempest Anderson and Professor A. W. Mayo Robson.

A COMMISSION has been appointed by the New York Board of Health to study the causes of pneumonia, with a view to checking the

increasing mortality. It consists of Drs. W. H. Welch and William Osler, of Johns Hopkins, Baltimore; E. G. Janeway, L. E. Holt and T. M. Prudden, of New York; Theobald Smith, of Harvard; Frank S. Billings, of Chicago, and John H. Musser, of Philadelphia.

PROFESSOR RONALD ROSS, of the University of Liverpool, will after his return from Panama, deliver a series of lectures in the Medical Department, of the University of Pennsylvania, on 'Causes and Cure of Malarial Fever.'

SIR CLIFFORD ALLBUTT, regius professor of medicine at Cambridge, Dr. Horatio C. Wood and Dr. John H. Musser made addresses at the opening of the medical department of the University of Pennsylvania, on September 30.

THE RT. HON. JAMES BRYCE, M.P., will deliver the Godkin lectures in Sanders Theater, Harvard University, on October 24, 26, 28, 31, and November 3. He will speak on 'The Study of Popular Governments.' He has accepted the invitation of Columbia University to deliver the first series of lectures upon the Carpentier foundation. The lectures will be given at 4 P.M., on October 10, 12, 14, 17, 19 and 21. Mr. Bryce's general subject will be: 'The Law in its Relations to History.'

PROFESSOR FREDERICK STARR, who holds the chair of anthropology, at the University of Chicago, has given a summer course of five weeks in studying the savage tribes as shown in the various exhibits at the St. Louis Fair.

PROFESSOR A. C. ABBOTT, of the University of Pennsylvania, gave the opening address before the faculty of medicine of McGill University, his subject being 'The Study of Medicine and Recent Advances in Medical Science.'

DR. I. C. WHITE, state geologist of West Virginia, sailed for Brazil, on July 5, where he will examine and report on the coal fields of Rio Grande do Sul.

DR. G. W. LEWIS, of the department of chemistry at Harvard University, has been given a two years' leave of absence to accept a government position in the Philippines.

MR. A. J. COX, instructor in chemistry in Stanford University, has returned after two years spent at the University of Breslau.

MR. ERNST BESSEY, who for three years has been studying abroad, has resumed his duties in the Bureau of Plant Industry at Washington. During Mr. Bessey's stay abroad he has acted in various capacities for the government. Several expeditions have been made by him into southwestern Russia and the Mediterranean coast region in search of new plants and seeds. A number of the promising forage crop seeds secured by him in Turkestan are now being grown and tested under the direction of the Bureau of Plant Industry.

WE learn from *The American Geologist* that at a recent meeting of the Virginia Board of Agriculture an appropriation was voted for a Geological Survey of the mineral resources of Virginia. The survey will be conducted jointly by the State Department of Agriculture and the Virginia Polytechnic Institute. Dr. Thomas L. Watson, professor of geology in the Polytechnic Institute, was appointed geologist in charge of the survey.

DR. A. E. MCDONALD retired on October 1, 1904, from the superintendency of the Manhattan City Hospital, Ward's Island, N. Y.; Dr. J. T. W. Rowe is retained as acting superintendent.

A MEMORIAL tablet to Dr. Jesse Lazear, who died in Cuba in 1900 while investigating the causes of yellow fever, has been unveiled at the new surgical building of the Johns Hopkins Hospital.

MAJOR HENRY F. ALVORD, chief of the dairy division of the United States Department of Agriculture, died at St. Louis on October 1, as the result of a stroke of paralysis.

MR. CLARENCE M. DALY, for sixteen years employed in the experimental department of Mr. Edison's laboratory, has died as a result, it is said, of cancerous growths on his hand caused by work with X-rays.

DR. O. REMBOLD, formerly professor of medicine at Innsbrück, has died at the age of seventy-one years.

MR. RONALD WILLIAM HENRY TURNBULL HUDSON, lecturer in mathematics at the Uni-

versity of Liverpool, with Mr. J. F. Cameron, lecturer of Caius College, Cambridge, was climbing a difficult *couloir*, near Bethesda, in north Wales, on September 20, when he dislodged a mass of rock, and, falling with it, was instantly killed. Mr. Hudson was twenty-eight years of age, and was the son of Professor W. H. H. Hudson, of King's College, London.

THERE will be a civil service examination on November 10 to fill the position of assistant to the agrostologist in the Bureau of Plant Industry at a salary of $1,400. On November 16 examinations will be held for the position of technical assistants in chemistry, pharmacology and zoology in the public health and marine hospital service, with salaries of not less than $1,000.

KING EDWARD has been pleased, upon the recommendation of the secretary for Scotland, to confer the title 'Royal' upon the Edinburgh Museum of Science and Art, and to approve its designation being altered to 'The Royal Scottish Museum.'

FOURTEEN large houses in Bloomsbury, London, have been demolished for the British Museum extension.

THE private herbarium of Dr. John K. Small, consisting of 21,900 sheets, fully representing his collections in the southern United States, has, we learn from the *Botanical Gazette*, been acquired by the Field Columbian Museum.

THE autumn intercollegiate geological excursion for professors, teachers and advanced students will be held at Worcester, October 22. The party will meet on the evening of October 21, at 8 o'clock, in the rooms of the Worcester Natural History Society, 12 State street, when explanation of the work of the next day will be given. The party will start at 8:30 A.M., October 22, from the Bay State House, on a special trolley car; and, after visiting localities in the eastern and northern parts of the city, will return to the hotel for dinner —price, 75 cents. In the afternoon the party will go on the trolley car to the southeastern part of the city, visiting interesting localities there. The works—'The Physical Geography of Southern New England,' by Wm. M. Davis; 'Physical Geography of Worcester,' by J. H. Perry; 'Geology of Worcester,' by J. H. Perry and B. K. Emerson—will make known the points of geological interest in the region. Those proposing to take part in the excursion will please inform Mr. J. H. Perry, 76 Highland street, Worcester, Mass., on or before October 18.

THE Liverpool School of Tropical Medicine proposes to despatch a second yellow fever expedition to the Amazon in view of the necessity of investigating still further this malady. The late Dr. Walter Myers was selected by the school, together with Dr. Herbert Durham, to undertake an expedition to Para to investigate the disease, only a few years ago. Both members of the expedition were attacked by the malady and Dr. Myers died. The expedition wil probably start at the end of the year.

WE learn from *Nature* that extensions made to Millport Marine Biological Station, including a new laboratory, research rooms, a tank-room and a library, the gifts of Mr. James Coats, Jr., of Paisley, were opened on September 27, by Sir John Primrose, lord provost of Glasgow.

WE learn from *Popular Astronomy* that in a circular accompanying the last issue of the *Astronomische Rundschau*, the sale of the instruments and library of Manora Observatory is announced. The telescope is spoken of as one of great excellence. Application should be made to Manora-Sternwarte 'Lussenpiccolo' (Istri).

ACCORDING to the *Experiment Station Record*, it is proposed to hold an International Congress of Agricultural Mechanics at the Universal Exposition of Liège in 1905, under the patronage of the Belgian Government. The organization has, however, not yet been perfected nor the program completed. A. Lonay, director of the provincial school of agricultural mechanics at Mons, is in charge of the preliminary arrangements. Among the topics which have been suggested for the program are instruction in agricultural mechanics, testing stations for agricultural machinery, exhibition and tests of machinery, application of electricity, the traction auto-

mobile, and the establishment of a review of agricultural mechanics.

THE exhibition of the Institute of Hygiene, recently opened in London, differs, according to the *Times*, from any exhibition previously held. It is under the auspices of a medical council and is controlled by medical experts. The intrinsic value of every exhibit is investigated by an examining board. Exhibits only of a high standard of merit are admitted. Every product, article, or appliance passed by the board is 'hall-marked' as to its purity, quality and excellence. Great care is exercised in maintaining the standard of exhibits —alike in the interest of the public health as of the exhibitors. It is recognized that any exhibit passed by the examining board may be used and recommended by medical practitioners. A certificate is granted to exhibitors by the institute, which constitutes a valuable award of merit. The exhibition is intended— (1) to supply medical men with practical information so as to enable them to keep abreast of the times in regard to the value and progress made in the various manufactured products and articles which affect health; (2) to supply matrons and nurses with useful knowledge in regard to those products and appliances required by invalids; (3) to supply the general public, and especially that large and increasing number who take an interest in dietetics, clothing, appliances and articles which are correlated with the health of the person or the home, with authoritative information as to their value and use. The exhibition is situated in Devonshire street, Harley street, in the west end of London and in the heart of the chief medical center of the country. Sample spaces only are allotted to exhibitors, so as to enable a large number and great variety of exhibits to be on view. The exhibition is a permanent one—open daily throughout the year, and is free to the public as well as to the medical profession.

THE *Experiment Station Record* states that the order establishing the soil and fertilizer laboratory in the Bureau of Chemistry, U. S. Department of Agriculture, has been abrogated, and in lieu of this laboratory one to be known as the plant analysis laboratory has been established. The laboratory is charged with the examination of fertilizers and will collaborate in this work with the referees of the Association of Official Agricultural Chemists, and with the investigation of the constitution of plants. It is authorized to collaborate with the Bureau of Plant Industry in the chemical investigation of problems in which the two bureaus are mutually interested. A leather and paper laboratory and a micro-chemical laboratory have also been established in this bureau. The latter is charged with micro-chemical investigations relating to the investigations of the Bureau of Chemistry, and especially the examination of food products with respect to their composition and adulteration. To the leather and paper laboratory will be assigned analyses and investigations relating to tannins and tanning material, all technical problems of a chemical nature relating to the production of leather, chemical and physical examinations of papers with reference to their fitness for use in this and other departments, and problems relating to the production of paper with a view to promoting the agricultural industries connected with the production of the raw materials and to the improvement of the quality of papers made.

UNIVERSITY AND EDUCATIONAL NEWS.

IT is said that Yale University will receive by the will of Mr. Levi Clinton Veits the sum of about $200,000.

THE veterinary department of the University of Pennsylvania has received an anonymous gift of $100,000.

COLUMBIA UNIVERSITY has received a gift of $16,250 from Mr. H. E. Garth for the establishment of a scholarship, and $10,000 from an anonymous donor for the purchase of books.

IT is said that the University of Chicago has received $250,000 for a building for the divinity school.

ACCORDING to the Boston *Transcript*, the Yale University Museum has received from the Royal Museum of Decorative and Industrial Arts at Brussels a large gift of antiquities collected in southern Spain. The collec-

tion represents the transition period between the ages of stone and of metal, and includes many stone and bronze implements, and also pottery. The museum has also received a collection of prehistoric implements collected in the valley of the Susquehanna, and presented by Christopher Wrenn, of Plymouth, Pa.

THE first portion of the $600,000 left by Charles F. Doe to the University of California for a new library building will be available this year; the plans are now being drawn for the building, and ground will be broken in the spring. Like California Hall, the administration building, which is being built by a state appropriation of $250,000, and like the Hearst memorial mining building, which Mrs. Hearst is erecting at a cost of half a million, the new library will be of California granite and fireproof.

THE new surgical building of the Johns Hopkins Hospital was opened last week.

AT the University of Oklahoma a new science hall, first opened for work at the beginning of the present semester, takes the place of the building recently destroyed by fire. The present structure, which is of gray pressed brick, was designed with ample window space in order to secure a maximum of light. It is fitted throughout with electricity, water and gas. The lower floor is occupied temporarily by the department of chemistry, the second floor by biology and the upper floor by geology. An auditorium, used by all departments, is supplied with a modern stereopticon. There are in all more than thirty rooms used as laboratories, offices, lecture and store rooms. Seven men give instruction in the building, and the enrolment in the various departments is much greater than during any previous year.

THE free lecture system of the New York Board of Education under Dr. Henry M. Leipziger will this year be extended so that there will be about 140 lecture centers.

ACCORDING to items in the daily papers, the entrance class at Harvard will number over 600, being its largest freshman class.

THE total attendance at Cornell University exceeds that of any previous year by 206 students. The regularly enrolled students this year number in all 3,300, and the entering class numbers 916, against 815 last September.

DR. CHARLES W. DABNEY will be installed as president of University of Cincinnati on November 16.

THE trustees of Northwestern University have announced the election of Dean Thomas F. Holgate, professor of mathematics, to be acting president of the institution.

DR. HENRY MILTON WHELPLEY, professor of microscopy in the St. Louis College of Pharmacy, has been elected dean of that institution. He has been a teacher in the college since 1884.

DR. C. J. KEYSER has been promoted to a professorship of mathematics at Columbia University.

MESSRS. JOHN FRAZER, Thomas McCutcheon and Walter Taggart have been appointed instructors in chemistry at the University of Pennsylvania.

THE following appointments have been made in the science departments of the University of Maine for the coming year:

H. S. Boardman, C.E. (Maine, 1895), has been promoted from associate professor to professor of civil engineering.

C. P. Weston, C.E. (Maine, 1900), Ph.D. (Columbia, 1904), has been appointed assistant professor of mechanics.

H. R. Willard, B.A. (Dartmouth, 1899), and M.A. (Dartmouth, 1901), instructor in mathematics.

W. K. Ganong, B.S. (Worcester Polytechnic Institute), instructor in electrical engineering.

A. L. Grover, B.C.E. (Maine, 1899), instructor in drawing.

R. K. Morley, B.A. and M.A. (Tufts, 1904), tutor in mathematics.

L. C. Smith, B.S. (Maine, 1904), assistant in chemistry.

Edith M. Patch, B.S. (Minnesota, 1902), Entomologist to the State Experiment Station.

MISS MARY J. HURLBURT has been appointed instructor in physics at Smith College. Miss Harriet W. Bigelow resumes her work in astronomy, after three years' absence.

MR. GEORGE H. CARPENTER, of the Science and Art Museum, Dublin, has been appointed professor of zoology in the Royal College of Science for Ireland.

SCIENCE

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FRIDAY, OCTOBER 21, 1904.

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THE HISTORY OF ANTHROPOLOGY.*

I HAVE been asked to speak on the history of anthropology. The task that has been allotted to me is so vast and the time at my disposal is so short, that it will be impossible to do justice to the work of the minds that have made anthropology what it is. It would even be futile to characterize the work of the greatest among the contributors to our science. All that I can undertake to do is to discuss the general conditions of scientific thought that have given rise to anthropology.

Viewing my task from this standpoint, you will pardon me if I do not first attempt to define what anthropology ought to be, and with what subjects it ought to deal, but if I take my cue rather from what it is, and how it has developed.

Before I enter into my subject I will say that the speculative anthropology of the 18th and of the early part of the 19th century is distinct in its scope and method from the science which is called anthropology at the present time and is not included in our discussion.

At the present time anthropologists occupy themselves with problems relating to the physical and mental life of mankind as found in varying forms of society, from the earliest times up to the present period, and in all parts of the world. Their researches bear upon the form and functions of the body as well as upon all kinds of manifestations of mental life. Accordingly, the subject matter of anthropology is partly a branch of biology, partly a branch of the mental sciences. Among the mental phenomena language, invention, art, religion, social organization and law have received particular attention. Among anthropologists of our time we find a consid-

* Address at the International Congress of Arts and Science, St. Louis, September, 1904.

erable amount of specialization of the subject matter of their researches according to the divisions here given.

As in other sciences whose subject matter is the actual distribution of phenomena and their causal relation, we find in anthropology two distinct methods of research and aims of investigation: the one, the historical method, which endeavors to reconstruct the actual history of mankind; the other, the generalizing method, which attempts to establish the laws of its development. According to the personal inclination of the investigator, the one or the other method prevails in his researches. A considerable amount of geographical and historical specialization has also taken place among what may be called the historical school of anthropologists. Some devote their energies to the elucidation of the earliest history of mankind, while others study the inhabitants of remote regions, and still others the survivals of early times that persist in our midst.

The conditions thus outlined are the result of a long development, the beginnings of which during the second half of the 18th century may be clearly observed. The interest in the customs and appearance of the inhabitants of distant lands is, of course, much older. The descriptions of Herodotus show that even among the nations of antiquity, notwithstanding their self-centered civilization, this interest was not lacking. The travelers of the Middle Ages excited the curiosity of their contemporaries by the recital of their experiences. The literature of the Spanish conquest of America is replete with remarks on the customs of the natives of the New World. But there is hardly any indication of the thought that these observations might be made the subject of scientific treatment. They were and remained curiosities. It was only when their relation to our own civilization became the subject of inquiry that the foundations of anthropology were laid. Its germs may be discovered in the early considerations of theologists regarding the relations between pagan religions and the revelations of Christianity. They were led to the conclusion that the lower forms of culture, more particularly of religion, were due to degeneration, to a falling away from the revealed truth, of which traces are to be found in primitive beliefs.

During the second half of the eighteenth century we find the fundamental concept of anthropology well formulated by the rationalists who preceded the French Revolution. The deep-seated feeling that political and social inequality was the result of a faulty development of civilization and that originally all men were born equal, led Rousseau to the naïve assumption of an ideal natural state which we ought to try to regain. These ideas were shared by many and the relation of the culture of primitive man to our civilization remained the topic of discussion. To this period belong Herder's 'Ideen zur Geschichte der Menschheit,' in which perhaps for the first time the fundamental thought of the development of the culture of mankind as a whole is clearly expressed.

About this time Cook made his memorable voyages and the culture of the tribes of the Pacific Islands became first known to Europe. His observations and the descriptions of Forster were eagerly taken up by students and were extensively used in support of their theories. Nevertheless even the best attempts of this period were essentially speculative and deductive, for the rigid inductive method had hardly begun to be understood in the domain of natural sciences, much less in that of the mental sciences.

While, on the whole, the study of the mental life of mankind had in its beginning decidedly a historical character, and while knowledge of the evolution of civilization

was recognized as its ultimate aim, the biological side of anthropology developed in an entirely different manner. It owes its origin to the great zoologists of the eighteenth century, and in conformity with the general systematic tendencies of the times, the main efforts were directed towards a classification of the races of man and to the discovery of valid characteristics by means of which the races could be described as varieties of one species or as distinct species. The attempts at classification were numerous, but no new point of view was developed.

During the nineteenth century a certain approach between these two directions was made, which may be exemplified by the work of Klemm. The classificatory aspect was combined with the historical one and the leading discussion related to the discovery of mental differences between the zoological varieties or races of men, and to the question of polygenism and monogenism. The passions that were aroused by the practical and ethical aspects of the slavery question did much to concentrate attention on this phase of the anthropological problem.

As stated before, most of the data of anthropology had been collected by travelers whose prime object was geographical discoveries. For this reason the collected material soon demanded the attention of geographers, who viewed it from a new standpoint. To them the relations between man and nature were of prime importance and their attention was directed less to psychological questions than to those relating to the dependence of the form of culture upon geographical surroundings, and the control of natural conditions gained by man with the advance of civilization.

Thus we find about the middle of the nineteenth century the beginnings of anthropology laid from three distinct points of view: the historical, the classificatory and the geographical. About this time the historical aspect of the phenomena of nature took hold of the minds of investigators in the whole domain of science. Beginning with biology, and principally through Darwin's powerful influence, it gradually revolutionized the whole method of natural and mental science and led to a new formulation of their problems. The idea that the phenomena of the present have developed from previous forms with which they are genetically connected and which determine them, shook the foundations of the old principles of classification and knit together groups of facts that hitherto had seemed disconnected. Once clearly enunciated, the historical view of the natural sciences proved irresistible and the old problems faded away before the new attempts to discover the history of evolution. From the very beginning there has been a strong tendency to combine with the historical aspect a subjective valuation of the various phases of development, the present serving as a standard of comparison. The oft-observed change from simple forms to more complex forms, from uniformity to diversity, was interpreted as a change from the less valuable to the more valuable and thus the historical view assumed in many cases an ill-concealed teleological tinge. The grand picture of nature in which for the first time the universe appears as a unit of ever-changing form and color, each momentary aspect being determined by the past moment and determining the coming changes, is still obscured by a subjective element, emotional in its sources, which leads us to ascribe the highest value to that which is near and dear to us.

The new historical view also came into conflict with the generalizing method of science. It was imposed upon that older view of nature in which the discovery of general laws was considered the ultimate aim of investigation. According to this

view laws may be exemplified by individual events, which, however, lose their specific interest once the laws are discovered. The actual event possesses no scientific value in itself, but only so far as it leads to the discovery of a general law. This view is, of course, fundamentally opposed to the purely historical view. Here the laws of nature are recognized in each individual event, and the chief interest centers in the event as an incident of the picture of the world. In a way the historic view contains a strong, esthetic element, which finds its satisfaction in the clear conception of the individual event. It is easily intelligible that the combination of these two standpoints led to the subordination of the historical fact under the concept of the law of nature. Indeed, we find all the sciences which took up the historical standpoint for the first time, soon engaged in endeavors to discover the laws according to which evolution has taken place. The regularity in the processes of evolution became the center of attraction even before the processes of evolution had been observed and understood. All sciences were equally guilty of premature theories of evolution based on observed homologies and supposed similarities. The theories had to be revised again and again, as the slow progress of empirical knowledge of the data of evolution proved their fallacy.

Anthropology also felt the quickening impulse of the historic point of view, and its development followed the same lines that may be observed in the history of the other sciences. The unity of civilization and of primitive culture that had been divined by Herder now shone forth as a certainty. The multiplicity and diversity of curious customs and beliefs appeared as early steps in the evolution of civilization from simple forms of culture. The striking similarity between the customs of remote districts was the proof of the uniform manner in which civilization had developed the world over. The laws according to which this uniform development of culture took place became the new problem which engrossed the attention of anthropologists.

This is the source from which sprang the ambitious system of Herbert Spencer and the ingenious theories of Edward Burnett Tylor. The underlying thought of the numerous attempts to systematize the whole range of social phenomena or one or the other of its features—such as religious belief, social organization, forms of marriage—has been the belief that one definite system can be found according to which all culture has developed, that there is one type of evolution from a primitive form to the highest civilization which is applicable to the whole of mankind, that notwithstanding many variations caused by local and historical conditions, the general type of evolution is the same everywhere.

This theory has been discussed most clearly by Tylor, who finds proof for it in the sameness of customs and beliefs the world over. The typical similarity and the occurrence of certain customs in definite combinations are explained by him as due to their belonging to a certain stage in the development of civilization. They do not disappear suddenly, but persist for a time in the form of survivals. These are, therefore, wherever they occur, a proof that a lower stage of culture of which these customs are characteristic has been passed through.

Anthropology owes its very existence to the stimulus given by these scholars and to the conclusions reached by them. What had been a chaos of facts appeared now marshaled in orderly array, and the great steps in the slow advance from savagery to civilization were drawn for the first time with a firm hand. We can not overestimate the influence of the bold general-

izations made by these pioneers of modern anthropology. They applied with vigor and unswerving courage the new principles of historical evolution to all the phenomena of civilized life, and in doing so sowed the seeds of the anthropological spirit in the minds of historians and philosophers. Anthropology, which was hardly beginning to be a science, ceased at the same time to lose its character of being a single science, but became a method applicable to all the mental sciences and indispensable to all of them. We are still in the midst of this development. The sciences first to feel the influence of anthropological thought were those of law and religion. But it was not long before ethics, esthetics, literature and philosophy in general were led to accept the evolutionary standpoint in the particular form given to it by the early anthropologists.

The generalized view of the evolution of culture in all its different phases which is the final result of this method may be subjected to a further analysis regarding the psychic causes which bring about the regular sequence of the stages of culture. Owing to the abstract form of the results, this analysis must be deductive. It can not be an induction from empirical psychological data. In this fact lies one of the weaknesses of the method which led a number of anthropologists to a somewhat different statement of the problem. I mention here particularly Adolf Bastian and Georg Gerland. Both were impressed by the sameness of the fundamental traits of culture the world over. Bastian saw in their sameness an effect of the sameness of the human mind and terms these fundamental traits 'Elementargedanken,' declining all further consideration of their origin, since an inductive treatment of this problem is impossible. For him the essential problem of anthropology is the discovery of the elementary ideas, and in further pursuit of the inquiry, their modification under the influence of geographical environment. Gerland's views agree with those of Bastian in the emphasis laid upon the influence of geographical environment on the forms of culture. In place of the mystic elementary idea of Bastian, Gerland assumes that the elements found in many remote parts of the world are a common inheritance from an early stage of cultural development. It will be seen that in both these views the system of evolution plays a secondary part only, and that the main stress is laid on the causes which bring about modifications of the fundamental and identical traits. There is a close connection between this direction of anthropology and the old geographical school. Here the psychic and environmental relations remain amenable to inductive treatment, while, on the other hand, the fundamental hypotheses exclude the origin of the common traits from further investigation.

The subjective valuation which is characteristic of most evolutionary systems, was from the very beginning part and parcel of evolutionary anthropology. It is but natural that in the study of the history of culture our own civilization should become the standard, that the achievements of other times and other races should be measured by our own achievements. In no case is it more difficult to lay aside the 'Culturbrille'—to use Von den Steinen's apt term—than in viewing our own culture. For this reason the literature of anthropology abounds in attempts to define a number of stages of culture leading from simple forms to the present civilization, from savagery through barbarism to civilization, or from an assumed presavagery through the same stages to enlightenment.

The endeavor to establish a schematic line of evolution naturally led back to new attempts at classification in which each group bears a genetic relation to the other.

Such attempts have been made from both the cultural and the biological point of view.

It is necessary to speak here of one line of anthropological research that we have hitherto disregarded. I mean the linguistic method. The origin of language was one of the much discussed problems of the nineteeth century, and owing to its relation to the development of culture, it has a direct anthropological bearing. The intimate ties between language and ethnic psychology were expressed by no one more clearly than by Steinthal, who perceived that the form of thought is molded by the whole social environment of which language is part. Owing to the rapid change of language, the historical treatment of the linguistic problem had developed long before the historic aspect of the natural sciences was understood. The genetic relationship of languages was clearly recognized when the genetic relationship of species was hardly thought of. With the increasing knowledge of languages they were grouped according to common descent, and when no further relationship could be proved, a classification according to morphology was attempted. To the linguist whose whole attention is directed to the study of the expression of thought by language, language is the individuality of a people, and therefore a classification of languages must present itself to him as a classification of peoples. No other manifestation of the mental life of man can be classified so minutely and definitely as language. In none are the genetic relations more clearly established. It is only when no further genetic and morphological relationship can be found, that the linguist is compelled to coordinate languages and can give no further clue regarding their relationship and origin. No wonder, then, that this method was used to classify mankind, although in reality the linguist classified only languages. The result of the classification seems eminently satisfactory on account of its definiteness as compared with the results of biological and cultural classifications.

Meanwhile the methodical resources of biological or somatic anthropology had also developed and had enabled the investigator to make nicer distinctions between human types than he had been able to make. The landmark in the development of this branch of anthropology has been the introduction of the metric method, which owes its first strong development to Quetelet. A little later we shall have to refer to this subject again. For the present it may suffice to say that a clearer definition of the terms 'type' and 'variability' led to the application of the statistical method by means of which comparatively slight varieties can be distinguished satisfactorily. By the application of this method it soon became apparent that the races of man could be subdivided into types which were characteristic of definite geographical areas and of the people inhabiting them. The same misinterpretation developed here as was found among the linguists. As they identified language and people, so the anatomists identified somatic type and people and based their classifications of peoples wholly on their somatic characters.

The two principles were soon found to clash. Peoples genetically connected by language, or even the same in language, were found to be diverse in type, and people of the same type were found to be diverse in language. Furthermore, the results of classifications according to cultural groups disagreed with both the linguistic and the somatic classifications. In long and bitter controversies the representatives of these three directions of anthropological research contended for the correctness of their conclusions. This war of opinions was fought out particularly on the ground

of the so-called Aryan question, and only gradually did the fact come to be understood that each of these classifications is the reflection of a certain group of facts. The linguistic classification records the historical fates of languages and indirectly of the people speaking these languages; the somatic classification records the blood relationships of groups of people and thus traces another phase of their history; while the cultural classification records historical events of still another character, the diffusion of culture from one people to another and the absorption of one culture by another. Thus it became clear that the attempted classifications were expressions of historical data bearing upon the unwritten history of races and peoples, and recorded their descent, mixture of blood, changes of language and development of culture. Attempts at generalized classifications based on these methods can claim validity only for that group of phenomena to which the method applies. An agreement of their results, that is, original association between somatic type, language and culture, must not be expected. Thus the historical view of anthropology received support from the struggles between these three methods of classification.

We remarked before that the evolutionary method was based essentially on the observation of the sameness of cultural traits the world over. On the one hand, the sameness was assumed as proof of a regular, uniform evolution of culture. On the other hand, it was assumed to represent the elementary idea which arises by necessity in the mind of man and which can not be analyzed, or as the earliest surviving form of human thought.

The significance of these elementary ideas or universal traits of culture has been brought into prominence by the long continued controversy between the theory of their independent origin and that of their transmission from one part of the world to another. This struggle began even before the birth of modern anthropology, with the contest between Grimm's theory of the origin and history of myths and Benfey's proof of transmissions, which was based on his learned investigations into the literary history of tales. It is still in progress. On the one hand, there are investigators who would exclude the consideration of transmission altogether, who believe it to be unlikely and deem the alleged proof irrelevant, and who ascribe sameness of cultural traits wholly to the psychic unity of mankind and to the uniform reaction of the human mind upon the same stimulus. An extremist in this direction was the late Daniel G. Brinton. On the other hand, Friedrich Ratzel, whose recent loss we lament, inclined decidedly to the opinion that all sameness of cultural traits must be accounted for by transmission, no matter how far distant the regions in which they are found. In comparison with these two views the third one, which was mentioned before as represented by Gerland, namely, that such cultural traits are vestiges or survivals of the earliest stages of a generalized human culture, has found few supporters.

It is evident that this fundamental question can not be settled by the continued discussion of general facts, since the various explanations are logically equally probable. It requires actual investigation into the individual history of such customs to discover the causes of their present distribution.

Here is the place to mention the studies in folklore which have excited considerable interest in recent times and which must be considered a branch of anthropological research. Beginning with records of curious superstitions and customs and of popular tales, folklore has become the science of all the manifestations of popular life.

Folklorists occupy themselves primarily with the folklore of Europe and thus supplement the material collected by anthropologists in foreign lands. The theorists of folklore are also divided into the two camps of the adherents of the psychological theory and those of the historical theory. In England the former holds sway, while on the continent the historical theory seems to be gaining ground. The identity of the contents of folklore all over Europe seems to be an established fact. To the one party the occurrence of these forms of folklore seems to be due in part to psychic necessity, in part to the survival of earlier customs and beliefs. To the other party it seems to owe its origin to the spread of ideas over the whole continent which may, in part at least, be followed by literary evidence.

However this controversy, both in folklore and in anthropology, may be settled, it is clear that it must lead to detailed historical investigations, by means of which definite problems may be solved, and that it will furthermore lead to psychological researches into the conditions of transmission, adaptation and invention. Thus this controversy will carry us beyond the limits set by the theory of elementary ideas, and by that of a single system of evolution of civilization.

Another aspect of the theories here discussed deserves special mention. I mean the assumption of a 'folk psychology' (Völkerpsychologie) as distinct from individual psychology. Folk psychology deals with those psychic actions which take place in each individual as a social unit, and the psychology of the individual must be interpreted by the data of a social psychology, because each individual can think, feel and act only as a member of the social group to which he belongs. The growth of language and all ethnic phenomena have thus been treated from the point of view of a social psychology, and special attention has been given to the subconscious influences which sway crowds and masses of people, and to the processes of imitation. I mention Steinthal, Wundt, Baldwin, Tarde, Stoll, among the men who have devoted their energies to these and related problems. Notwithstanding their efforts, and those of a number of sociologists and geographers, the relation of 'folk psychology' to individual psychology has not been elucidated satisfactorily.

We will now turn to a consideration of the recent history of somatology. The historical point of view wrought deep changes also in this branch of anthropology. In place of classification the evolution of human types became the main object of investigation. The two questions of man's place in nature and of the evolution of human races and types came to the front. The morphological and embryological methods which had been developed by biologists were applied to the human species and the new endeavors were directed to the discovery of the predecessor of man, to his position in the animal series, and to evidences regarding the direction in which the species develops. I need mention only Huxley and Wiedersheim to characterize the trend of these researches.

In one respect, however, the study of the human species differs from that of the animal series. I stated before that the slight differences between types which are important to the anthropologist had led to the substitution of the metric quantitative description for the verbal or qualitative method. The study of the effects of natural selection, of environment, of heredity, as applied to man, made the elaboration of these methods a necessity. Our interest in slight differences is so much greater in man than in animals or plants, that here the needs of quantitative precision were first felt. We owe it to Francis Galton that the methods of the quantitative study of the

varieties of man have been developed and that the study has been extended from the field of anatomy over that of physiology and experimental psychology. His researches were extended and systematized by Karl Pearson, in whose hands the question which was originally one of the precise treatment of the biological problem of anthropology has outgrown its original limits and has become a general biological method for the study of the characteristics and of the development of varieties.

We may now summarize the fundamental problems which give to anthropology its present character. In the biological branch we have the problem of the morphological evolution of man and that of the development of varieties. Inseparable from these questions is also that of correlation between somatic and mental characters which has a practical as well as a theoretical interest. In psychological anthropology the important questions are the discovery of a system of the evolution of culture, the study of the modifications of simple general traits under the influence of different geographical and social conditions, the question of transmission and spontaneous origin, and that of folk psychology *versus* individual psychology. It will, of course, be understood that this enumeration is not exhaustive, but includes only some of the most important points of view that occupy the minds of investigators.

The work of those students who are engaged in gathering the material from which this history of mankind is to be built up is deeply influenced by these problems. It would be vain to attempt to give even the briefest review of what has been achieved by the modest collector of facts, how his efforts have covered the remotest parts of the world, how he has tried to uncover and interpret the remains left by the races of the past.

I think we may say, without injustice, that his work is directed principally to the explanation of special problems that derive their chief interest from a personal love for the particular question and an ardent desire to see its obscurity removed and to present its picture in clear outlines. Nevertheless the well trained and truly scientific observer will always be aware of the general relations of his special problem and will be influenced in his treatment of the special question by the general theoretical discussions of his times. It must be said with regret that the number of anthropological observers who have a sufficient understanding of the problems of the day is small. Still their number has increased considerably during the last twenty years and consequently a constant improvement in the reliability and thoroughness of the available observations may be noticed.

One or two aspects of the research work of the field anthropologist must be mentioned. The studies in prehistoric archæology have been given a lasting impulse by the discussions relating to the evolution of mankind and of human culture. Two great problems have occupied the attention of archæologists, the origin and first appearance of the human race, and the historical sequence of races and of types of culture. To the archæologist the determination of the chronological order is an important one. The determination of the geological period in which man appeared, the chronological relation of the earliest types of man to their later successors, the sequence of types of culture as determined by the artifacts of each period, and approximate determinations of the absolute time to which these remains belong are the fundamental problems with which archæology is concerned. The results obtained have the most immediate bearing upon the general question of the evolution of culture, since the ideal aim of archæology practically coincides with this general problem, the solution of which

would be contained in a knowledge of the chronological development of culture. Of course, in many cases the chronological question can not be answered and then the archæological observations simply rank with ethnological observations of primitive people.

The field work of ethnologists has been influenced in several directions by the theoretical discussions of anthropologists. We do not need to dwell on the fact that the scope of ethnological research has become more extensive and exhaustive by taking into consideration more thoroughly than before the whole range of cultural phenomena. More interesting than this is the stimulus that has been given to historic and psychological observation. On the one hand, the theory of transmission has induced investigators to trace the distribution and history of customs and beliefs with care so as to ascertain empirically whether they are spontaneous creations or whether they are borrowed and adapted. On the other hand, the psychic conditions that accompany various types of culture have received more careful attention.

These detailed archæological and ethnological studies have retroacted upon the theories of anthropology. The grand system of the evolution of culture, that is valid for all humanity, is losing much of its plausibility. In place of a simple line of evolution there appear a multiplicity of converging and diverging lines which it is difficult to bring under one system. Instead of uniformity the striking feature seems to be diversity. On the other hand, certain general psychic facts seem to become discernible, which promise to connect folk psychology with individual psychology. The trend of this development is familiar to us in the history of other sciences, such as geology and biology. The brilliant theories in which the whole range of problems of a science appears simple and easily explorable have always preceded the periods of steady empirical work which make necessary a complete revision of the original theories and lead through a period of uncertainty to a more strictly inductive attack of the ultimate problems. So it is with anthropology. Later than the older sciences, it has outgrown the systematizing period and is just now entering upon the empirical revision of its theories.

Our sketch of the history of the prevailing tendencies in anthropology would be incomplete without a few remarks on the men who have made it what it is. What has been said before shows clearly that there is hardly a science that is as varied in its methods as anthropology. Its problems have been approached by biologists, linguists, geographers, psychologists, historians and philosophers. Up to ten years ago we had no trained anthropologists, but students drifted into anthropological research from all the sciences that I have mentioned here and perhaps from others. With many it was the interest aroused by a special problem, not theoretical considerations, that decided their course. Others were attracted by a general interest in the evolution of mankind. The best among them were gradually permeated by the fundamental spirit of anthropological research, which consists in the appreciation of the necessity of studying all forms of human culture, because the variety of its forms alone can throw light upon the history of its development, past and future, and which deigns even the poorest tribe, the degraded criminal and the physical degenerate worthy of attentive study because the expressions of his mental life, no less than his physical appearance, may throw light upon the history of mankind.

Even now the multifarious origin of anthropology is reflected in the multiplicity of its methods. The historian or the political economist who comes into contact with

anthropological problems can not follow the methods of the biologist and of the linguist. Neither can the anthropologist of our period fill the demands for information of all those who may need anthropological data. It might almost seem that the versatility required of him will set a limit to his usefulness as a thorough scientist. However, the solution of this difficulty is not far off. We have seen that a great portion of the domain of anthropology has developed through the application of the new historical point of view to the mental sciences. To those who occupy themselves with this group of problems anthropological knowledge will be indispensable. Though the anthropological point of view may thus pervade the treatment of an older branch of science and help to develop new standpoints, the assistance that anthropology renders it does not destroy the independence of the older science which in a long history has developed its own aims and methods. Conscious of the invigorating influence of our point of view and of the grandeur of a single all-compassing science of man, enthusiastic anthropologists may proclaim the mastery of anthropology over older sciences that have achieved where we are still struggling with methods, that have built up noble structures where chaos reigns with us; the trend of development points in another direction, in the continuance of each science by itself, assisted where may be by anthropological methods. The practical demands of anthropology also demand a definition and restriction of its field of work rather than constant expansion.

The historical development of the work of anthropologists seems to single out clearly a domain of knowledge that heretofore has not been treated by any other science. It is the biological history of mankind in all its varieties; linguistics applied to people without written languages; the ethnology of people without historic records, and prehistoric archæology. It is true that these limits are constantly being overstepped, but the unbiased observer will recognize that in all other fields special knowledge is required which can not be supplied by general anthropology. The *general* problem of the evolution of mankind is being taken up now by the investigator of primitive tribes, now by the student of the history of civilization. We may still recognize in it the ultimate aim of anthropology in the wider sense of the term, but we must understand that it will be reached by cooperation between all the mental sciences and the efforts of the anthropologist.

The field of research that has been left for anthropology in the narrower sense of the term is, even as it is, almost too wide, and there are indications of its breaking up. The biological, linguistic and ethnologic-archæological methods are so distinct that on the whole the same man will not be equally proficient in all of them. The time is rapidly drawing near when the biological branch of anthropology will be finally separated from the rest and become a part of biology. This seems necessary, since all the problems relating to the effect of geographical and social environment and those relating to heredity are primarily of a biological character. Problems may be set by the general anthropologist. They will be solved by the biologist. Almost equally cogent are the reasons that urge on to a separation of the purely linguistic work from the ethnological work. I think the time is not far distant when anthropology pure and simple will deal with the customs and beliefs of the less civilized people only, and when linguistics and biology will continue and develop the work that we are doing now because no one else cares for it. Nevertheless, we must always demand that the anthropologist who carries on field research must be familiar with the principles

would be contained in a knowledge of the chronological development of culture. Of course, in many cases the chronological question can not be answered and then the archæological observations simply rank with ethnological observations of primitive people.

The field work of ethnologists has been influenced in several directions by the theoretical discussions of anthropologists. We do not need to dwell on the fact that the scope of ethnological research has become more extensive and exhaustive by taking into consideration more thoroughly than before the whole range of cultural phenomena. More interesting than this is the stimulus that has been given to historic and psychological observation. On the one hand, the theory of transmission has induced investigators to trace the distribution and history of customs and beliefs with care so as to ascertain empirically whether they are spontaneous creations or whether they are borrowed and adapted. On the other hand, the psychic conditions that accompany various types of culture have received more careful attention.

These detailed archæological and ethnological studies have retroacted upon the theories of anthropology. The grand system of the evolution of culture, that is valid for all humanity, is losing much of its plausibility. In place of a simple line of evolution there appear a multiplicity of converging and diverging lines which it is difficult to bring under one system. Instead of uniformity the striking feature seems to be diversity. On the other hand, certain general psychic facts seem to become discernible, which promise to connect folk psychology with individual psychology. The trend of this development is familiar to us in the history of other sciences, such as geology and biology. The brilliant theories in which the whole range of problems of a science appears simple and easily explorable have always preceded the periods of steady empirical work which make necessary a complete revision of the original theories and lead through a period of uncertainty to a more strictly inductive attack of the ultimate problems. So it is with anthropology. Later than the older sciences, it has outgrown the systematizing period and is just now entering upon the empirical revision of its theories.

Our sketch of the history of the prevailing tendencies in anthropology would be incomplete without a few remarks on the men who have made it what it is. What has been said before shows clearly that there is hardly a science that is as varied in its methods as anthropology. Its problems have been approached by biologists, linguists, geographers, psychologists, historians and philosophers. Up to ten years ago we had no trained anthropologists, but students drifted into anthropological research from all the sciences that I have mentioned here and perhaps from others. With many it was the interest aroused by a special problem, not theoretical considerations, that decided their course. Others were attracted by a general interest in the evolution of mankind. The best among them were gradually permeated by the fundamental spirit of anthropological research, which consists in the appreciation of the necessity of studying all forms of human culture, because the variety of its forms alone can throw light upon the history of its development, past and future, and which deigns even the poorest tribe, the degraded criminal and the physical degenerate worthy of attentive study because the expressions of his mental life, no less than his physical appearance, may throw light upon the history of mankind.

Even now the multifarious origin of anthropology is reflected in the multiplicity of its methods. The historian or the political economist who comes into contact with

anthropological problems can not follow the methods of the biologist and of the linguist. Neither can the anthropologist of our period fill the demands for information of all those who may need anthropological data. It might almost seem that the versatility required of him will set a limit to his usefulness as a thorough scientist. However, the solution of this difficulty is not far off. We have seen that a great portion of the domain of anthropology has developed through the application of the new historical point of view to the mental sciences. To those who occupy themselves with this group of problems anthropological knowledge will be indispensable. Though the anthropological point of view may thus pervade the treatment of an older branch of science and help to develop new standpoints, the assistance that anthropology renders it does not destroy the independence of the older science which in a long history has developed its own aims and methods. Conscious of the invigorating influence of our point of view and of the grandeur of a single all-compassing science of man, enthusiastic anthropologists may proclaim the mastery of anthropology over older sciences that have achieved where we are still struggling with methods, that have built up noble structures where chaos reigns with us; the trend of development points in another direction, in the continuance of each science by itself, assisted where may be by anthropological methods. The practical demands of anthropology also demand a definition and restriction of its field of work rather than constant expansion.

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of these three methods, since all of them are needed for the investigation of his problems. No less must we demand that he has a firm grasp of the general results of the anthropological method as applied by various sciences. It alone will give his work that historic perspective which constitutes its higher scientific value.

A last word as to the value that the anthropological method is assuming in the general system of our culture and education. I do not wish to refer to its practical value to those who have to deal with foreign races or with national questions. Of greater educational importance is its power to make us understand the roots from which our civilization has sprung, that it impresses us with the relative value of all forms of culture, and thus serves as a check to an exaggerated valuation of the standpoint of our own period, which we are only too liable to consider the ultimate goal of human evolution, thus depriving ourselves of the benefits to be gained from the teachings of other cultures and hindering an objective criticism of our own work.

Franz Boas.

*PLANT MORPHOLOGY.**

Those who organized these congresses left to the guests whom they honored with their invitation a high degree of freedom in the handling of their subject. In the exercise of that freedom, which I gratefully acknowledge, I have decided not to attempt any general dissertation on the present position of plant morphology as a whole, but to discuss certain topics only in the morphology of plants, which at present take a prominent place in that branch of the science of botany. These center round the question of the relation of the axis to the leaf in vascular plants.

* Address delivered at the International Congress of Arts and Science, St. Louis, September, 1904. The full text will be published in the official proceedings.

We may, I think, date the foundation of a scientific comparative morphology of plants from the publication of the 'Vergleichende Untersuchungen' of Hofmeister, and his recognition of the fundamental homologies between mosses, ferns and other plants. But notwithstanding the soundness of Hofmeister's comparisons for the alternating generations as a whole, the homologies of the parts remained unsatisfactory; the chief reason for this was that their grouping was not derived from the comparison of nearly allied species; nor does it seem to have been held as important to consider critically whether such parts as were grouped together were or were not comparable as regards their descent. For long years after the publication of the 'Origin of Species' homology had no evolutionary significance in the practise of plant morphology. But in the sister science of zoology this matter was taken up by Ray Lankester, in 1870, in his paper 'On the Use of the Term Homology in Modern Zoology, and the Distinction Between Homogenetic and Homoplastic Agreements.' (Many botanists of the present day would be the better for a careful study of that essay.) He pointed out that the term homology, as then used by zoologists, belonged to the Platonic school, and involved reference to an ideal type. This meaning lay at the back of Goethe's theory of metamorphosis in plants, and it seems to have been somewhat in the same sense that homologies were traced by Hofmeister. Lankester showed that the zoologist's use of the term 'homologous' included various things; he suggested the introduction of a new word to define strict homology by descent; structures which are genetically related in so far as they have a single representative in a common ancestor, he styled 'homogeneous'; those which correspond in form, but are not genetically related, he termed 'homoplastic.'

It is important at once to recognize that the strict 'homogeny' defined by Lankester as that of 'structures which are genetically related in so far as they have a single representative in a common ancestor' can only be traced in the simpler cases of plant form: it implies the repetition of individual parts, so strictly comparable in number and position as to stamp the *individual identity* of those parts in the successive generations. The right hand of a child repeats in position and qualities the right hand of the mother and of the race at large; here is a strict homogeny. In the plant body such individual identity of parts of successive generations is not common. It may be traced, for instance, in the cotyledons, and the first plumular leaves of seedlings of nearly related species, or in their first roots. But as a consequence of that continued embryology, which is so constant a feature in the plant body, the number of the appendages of any individual is liable to be indefinitely increased, while often the absence of strict rule in their relative positions makes their identical comparison in different individuals impossible. This is especially clear in the case of roots of the second, and higher orders; for they do not correspond in exact number or position in seedlings. What we recognize in such cases is then, not the individual identity, but their similarity in other respects; and when we group them under the same head we recognize, not their strict homogeny according to the definition of Lankester, but their essential correspondence, as based upon the similarity of their structure, and of their mode of origin upon, and attachment to, the part which bears them. This is also the case with the antheridia and archegonia of the pteridophytes, which are as a rule definite neither in number nor in arrangement, and are subject to variation in both respects, according to the conditions which may be imposed upon them by experiment; nevertheless they accurately maintain their structural characters, and their essential correspondence is thus established, but not their individual identity. It is clear that this is a comparison of a more lax order than the recognition of their individual homogeny would be.

But if room for doubt of the strictest homogeny be found in simple cases such as these, what are we to expect from the comparisons of less strictly similar parts of the plant, such as cotyledons, scale leaves, foliage leaves, bracts, sepals, petals, stamens, carpels? How far are these to be held to be homogeneous, or in some less strict sense homologous? Or, going still further, how are we to regard those comparisons which deal with parts of different individuals, species, genera, orders or classes? What degree of homology is to be accorded to them? In proportion as the systematic remoteness of the plants compared increases, and the continuity of the connecting forms is less complete, so the comparisons become more and more doubtful, and the use of the term 'homology' as applied to them more and more lax, until we are finally landed in the region where comparison is little better than surmise. It becomes ultimately a question how far the term 'homology' is to be held as covering these more lax comparisons, which are certainly not examples of 'homogeny' in Lankester's sense, and are only doubtfully correlated together on a basis of comparison of more or less allied forms.

The progress of our science should be leading towards a refinement of the use of the term 'homology'; an approach must be made, however distant it may yet be, to a classification of parts on a basis of descent. But though that may be readily accepted in theory, it is still far from being adopted in the general practise of

plant morphology. None the less, comparison is inevitably leading to the disintegration, on a basis of descent, of the old-accepted categories of parts; of these the most prominent, and at the same time the most debatable, is the category of leaves, and they will lend themselves best to the illustration of the matter in hand.

To those who, like myself, hold the view that the two alternating generations of the Archegoniatæ have had a distinct phylogenetic history, it will be clear that their parts can not be truly comparable by descent. The leaf of the vascular plant, accordingly, will not be the correlative of the leaf of a moss. Even those who regard the sporophyte as an unsexed gametophyte will still have to show, on a basis of comparison and development, that the leaves of the two generations are of common descent. I am not aware that this has yet been done by them.

But the phylogenetic distinctness of the leaves in the sporophyte and gametophyte is not the only example of parallel foliar development. Goebel has shown with much cogency that the foliar appendages of the bryophytes are not all comparable as regards their origin; he remarks, 'It is characteristic that the leaf formation in the liverworts has arisen independently in quite a number of series' ('Organographie,' p. 261), and has shown that they must have been produced in different ways. Here then is polyphyleticism in high degree, seen in the origin of those parts of the gametophyte which on grounds of descent we have already separated from the foliar appendages of the sporophyte.

Such results as these for the gametophyte lead us to enquire into the views current as to the origin of foliar differentiation in vascular plants. In discussing such questions, it is to be remembered that in different stocks the foliar condition of the sporophyte as we see it may have been achieved in different ways, just as investigators have found reason to believe that it was in the gametophyte. We have no right to assume that the leaf was formed once for all in the descent of the sporophyte. But at the moment we are unprovided with any definite proof how it occurred. All the evidence on the point is necessarily indirect, since no intermediate types are known between foliar and non-foliar sporophytes. Physiological experiment has as yet nothing to say on the subject. The fossil history of the origin of the foliar state in the neutral generation is lost, for the foliar character antedated the earliest known fossil-sporophytes. There remain the facts of development of the individual, and comparison, while anatomical detail may have some bearing also on the question; but all of these, as indirect lines of evidence, fall short of demonstration, and accordingly it is impossible to come at present to any decision on the point. For the purposes of this discussion, however, we shall proceed on the supposition that all leaves of the sporophyte generation originated in essentially the same way, though not necessarily along the same phyletic line.

There are at least three alternatives possible for the origin of the foliar differentiation of the shoot, in any progressive line of evolution of vascular sporophytes: (1) That the prototype of the leaf was of prior existence, the axis being a part which gradually asserted itself as a basis for the insertion of those appendages; the leaf in such a case would be from the first the predominant part in the construction of the shoot. (2) That the axis and leaf are the result of differentiation of an indifferent branch-system, of which the limbs were originally all alike; in this case neither leaf nor axis would predominate from the first. (3) That the axis preexisted, and the foliar appendages arose as outgrowths upon it; in

this case the axis would be from the first the predominant part.

The first of the above alternatives, viz., that the prototype of the leaf existed from the first, and was indeed the predominant part in the initial composition of the shoot, has been held by certain writers as the basis of origin of the leafy shoot in vascular plants.* On this view not only is the whole shoot regarded as being mainly composed of leaves, but some even contend that the axis has no real existence as a part distinct from the leaf bases.†

This view in its general form represented the plant as constructed on a plan somewhat similar to that of a complex zoophyte. It has more recently culminated in the writings of Celakovsky and Delpino. The former in his theory of shoot-segments ('Sprossgliedlehre') starts from the position that the plant is composed of morphological individuals; the cell, the shoot and the plant stock are recognized as such. The stock is composed of shoots, and the shoot of cells. Braun recognized the shoot as the individual *par excellence;* between the cell and the shoot is a great gulf, which has not yet been filled; 'between the cell and the bud (shoot) there must be intermediate steps, the limitation of which no one has succeeded in defining'; the long sought for individual middle step is the shoot segment (Spross-glied), which is neither leaf only, nor stem segment only, but the leaf together with its stem segment. Now this appears to me to be purely Platonic morphology; the intermediate step *must* occur; we will, therefore, discover and define it. The definition of it consists in the drawing of certain transverse and longitudinal lines partitioning the shoot, lines which in the sporophyte have no existence in nature; the assumed necessity of partitioning the shoot into parts of an intermediate category between the whole shoot and the cell brings these assumed limits into existence.

Notwithstanding the ingenuity of the theory as put forward by Celakovsky, in the absence of any structural indication of the limits of the shoot segments in the vast majority of cases the theory does not appear to me to be sufficiently upheld by the facts.

An extreme, and indeed a paradoxical position has been taken on this phytonic question by Delpino. As a consequence of his studies on phyllotaxis he concluded that the axis is simply composed of the fusion of the leaf bases; that the leaves are not appendicular organs, but central organs; that an axis or stem system does not exist, and accordingly that the higher plants are not cormophytes at all, but phyllophytes. There will, I think, be few who will adopt this fantastic view of the shoot.

The second view, that the axis and leaf are the result of differentiation of an indifferent branch system, of which the limbs were originally all alike, has lately been brought into prominence by Potonié.* Taking his initiative from the branching of the leaves in early fossil ferns, he recognizes the frequent occurrence of overtopping ('Uebergipfelung'), that is, the gradual process of assertion of certain limbs of a branch system over others; in the branching of fucoids he finds an analogy for his observations on fern leaves, and draws the following conclusion, that 'the leaves of the higher plants have been derived in the

* Goethe, 'Die Metamorphose der Pflanzen.' Gaudichaud, *Mem. de l'Acad. d. Sci.*, 1841. Kienitz Gerloff, *Bot. Zeit.*, 1875, p. 55. Celakovsky, 'Unters. ueber die Homologien,' *Pringsh. Jahrb.*, XIV., p. 321, 1884; *Bot. Zeit*, 1901, Heft. v., VI.

† Delpino, 'Teoria generale della Filotassi.' For ref. see *Bot. Jahresbr.*, VIII., 1880, p. 118, also Vol. XI., 1883, p. 550.

* 'Lehrbuch d. Pflanzenpalæontologie,' pp. 156–159. Also 'Ein Blick in die Geschichte d. Bot. Morph. und d. Pericaulomtheorie,' 1903, p. 33, etc.

course of generations from parts of an algal thallus like that of *Fucus*, or at least from alga-like plants, by means of the overtopping of dichotomous branches, 'and the development as leaves of the branches, which thus become lateral.' Dr. Hallier, who adopts Potonié's position, prefers to draw the comparison with liverworts, which show a similar sympodial development of a dichotomous branch system.*

It seems not improbable that the condition of many branched fern leaves may have been derived through a process of 'overtopping' in an indifferent branch system of the leaf itself. But it lies with Potonié to show, on a basis of comparison of forms more nearly related to them than the fucoids, that the relation of axis to leaf in the ferns was so derived; and, further, that such an origin is in any way applicable to other foliar developments in vascular plants, especially pteridophytes such as the lycopods, equiseta and sphenophylls. I am not aware that this has yet been done. But granting that this can be done, the question still remains whether similarity of method of branching is any criterion of comparison as to descent. And especially whether such comparison is valid between widely distant groups, or between the different generations of an antithetic alternation. It is true that Potonié prefers to regard such generations as homologues, as is indeed essential for his view; but that does not prevent others from differing from him, or even considering the fact that the parts compared belong to different generations as fatal to his theory. For my own part, I am not prepared to give up the broad conclusions as to antithetic alternation on so slender a ground as similarity of method of branching represented in them both. For sympodial development of a dichotomous system (and this is all that such 'overtopping' actually is) has occurred in cases where it can not be held to have resulted in a branching which is foliar; and of this instances can be found without going so far afield as the Fucaceæ. If this be so, then little value need be attached to the comparison of such branchings in plants not nearly allied to one another; these may be held to be quite distinct examples of a general phenomenon, without the one being in any sense the prototype of the other. Such reflections as these indicate that the comparison in mode of branching between the leaves of ferns and the thallus of fucoids, which forms the groundwork of the view of Potonié (or between the ferns and the thalloid liverworts, as may be preferred by others), are not to be held as more than distant analogies; consequently they are no demonstration of the origin of the leaf by a process of 'overtopping.'

There remains the third view, which, however, is no new one; for there have not been wanting those who have assigned a more prominent place to the axis in the initial differentiation of the shoot. Perhaps the most explicit statement on this point is that by Alexander Braun, who remarks in his 'Rejuvenescence in Nature' (English edition, p. 107), referring to phytonic theories, that 'all these attempts to compose the plant of leaves are wrecked upon the fact of the existence of the stem as an original, independent and connected structure, the more or less distinct articulation of which certainly depends upon the leaf formation, but the first formation of which precedes that of the leaves.' Unger also in his botanical letters to a friend (No. VIII.), described how 'The first endeavor is directed towards the building up with cell-elements of an axis'—'those variously formed supplementary organs which are termed leaves originate laterally upon it'

* 'Beitrage z. Morph. d. Sporophylle u. d. Trophophylls,' Hamburg, 1902.

and he concludes that 'we may [therefore] say with perfect justice that the plant * * * is, as regards form, essentially a system of axes.' Naegeli contemplated a somewhat similar origin of the leafy shoot, as an alternative possibility; in fact, that the apex of a sporogonium-like body elongated directly into that of the leafy stem, in which case the axis would be the persistent and prominent part, and the leaves be from the first subsidiary, and lateral appendages. In my theory of the strobilus in archegoniate plants the central idea was somewhat similar to this. It may be briefly stated thus: There seems good reason to hold that a body of radial construction, having distinction of apex and base, and localized apical growth as its leading characters, existed prior to the development of lateral appendages in the sporophyte; for such a body is seen in certain bryophyte sporogonia, while the prior existence of the axis and lateral origin of the appendages upon it are general for normal leafy shoots. The view thus put forward is, indeed, the mere reading of the story of the evolution of leaves in terms of their normal individual development. I have recently shown that all pteridophyte shoots may be regarded as derivatives from the radial strobiloid type, with relatively small leaves, which would thus have come into existence.

It is natural to look to the pteridophytes for guidance as to the origin of foliar development in the sporophyte, for they are the most primitive plants with leafy sporophytes. They may be disposed according to the prevalent size of their leaves in a series, leading from microphyllous to megaphyllous types. I have lately shown that such a seriation is not according to one feature only, but that certain other characters which have been summarized as 'filicineous' tend to follow with the increasing prominence of the leaf. This indicates that such seriation is a natural arrangement. Now it is possible to hold either that the large-leaved fern-like plants were the more primitive, and the smaller-leaved, derivatives from them by reduction; or, conversely, that the smaller-leaved were the more primitive, and the larger-leaved derivatives from them by leaf-enlargement; other alternative opinions are also possible, such as that the leaf origin has been divergent from some middle type, or that the leaves of vascular plants may have been of polyphyletic origin.* For the moment we shall leave these latter alternatives aside.

Much of the difference of view as to foliar origin centers round the question whether originally the leaf was relatively large or small. Those who hold that the large-leaved forms were the more primitive will be naturally disposed towards the view of the original preponderance of the leaf

* The view recently advanced by Professor Lignier ('Equisetales, et Sphenophyllales. Leur origine filicinienne commune,' *Bull. Soc. Linn. de Normandie*, Serie 5, Vol. 7, Caen, 1903) is analogous to that of Potonié, though differing from it in detail. It involves the ranking of the lycopod leaf as a 'phylloid,' the leaf of the fern as a true leaf, or 'phyllome,' differentiated from an indifferent system of 'cauloids,' on which the 'phylloid' appendages had become abortive. It regards the leaves of equiseta and sphenophylls as phyllomes, reduced from the larger-leaved fern-type. The argument is chiefly based on comparisons as to branching and anatomical structure. I do not think that these grounds suffice to override the probability that the leaves of lycopods are essentially of the same nature as those of the sphenophylls or equiseta (compare my 'Studies,' No. V.). Professor Lignier's view further involves the acceptance of homologous alternation, while he makes no mention of the chromosome-differences of the two generations. Such difficulties do not arise if the leaves of the sphenophylls and equiseta are regarded as being in the upward rather than the downward scale of development, a view of them which would equally harmonize with the anatomical comparisons of Professor Lignier.

over the axis, and will favor some phytonic theory; those who hold the smaller-leaved forms to be the more primitive will probably adopt a strobiloid theory of origin of the leafy sporophyte. I propose to offer some remarks on the relative probability of these alternative views.

If large-leaved prototypes be assumed generally for vascular plants, this naturally involves a widespread reduction, since small-leaved forms are numerous now, and have been from the earliest times of which we have any record. Reduction is a ready weapon in the hands of the speculative morphologist, and it has often been used with more freedom than discretion. But reduction should never be assumed in order to meet the demands of convenience of comparison, nor as a cover for doubt. The justification of a view involving reduction must be found in its physiological probability in the case in question, and this should be backed by comparisons of form and of anatomical structure; the conclusion should also be in accordance with the paleontological record. All suggested cases of reduction where such justification is absent should be looked upon as doubtful.

Convincing evidence of reduction of leaf complexity in an evolutionary sequence, supported on all these grounds, has been adduced in the progression from ferns, through cycado-filicinean forms, to the cycads; and it applies with special force in the case of their sporophylls. Ferns, which are essentially shade-loving and typically zoidiogamic, or amphibious, may be understood to have given rise to the cycado-filices, and cycads, which are more xerophytic, and show that essential character of land plants—the seed habit. Not only is such a progression physiologically probable, but it is supported by paleontological evidence, as well as by detailed facts of anatomy, and of reproductive morphology. The case for reduction of leaf complexity seems to be here fully made out, and somewhat similar arguments will also apply for other types of gymnosperms.

The facts relating to the vascular system of the shoot have also their bearing on the question of the relative size of primitive leaves. The origin of the leaf trace from the axial stele in conifers, and also in angiosperms, has been shown by Dr. Jeffrey to be of the type styled by him phyllosiphonic. This is specially characteristic of those plants where the leaf is essentially the dominating influence in the shoot. In this I see a probability, which their physiological position as land-growing plants would justify, that the seed-bearing plants at large were descended from a large-leaved ancestry, and had undergone reduction of leaf complexity in their descent. But while we thus recognize a probability of widespread reduction producing relatively smaller-leaved forms, it does not follow that *all* small-leaved vascular plants originated thus. On this point the anatomical evidence is of importance, as bearing on the origin of the small-leaved strobiloid pteridophytes. Of these (putting aside the hydropterids as being a special reduction problem in themselves), there remain the Lycopodiales, the Equisetales and the Sphenophyllales, which are all cladosiphonic in the terminology of Dr. Jeffrey. The question will largely turn upon the meaning of this anatomical feature. I take it to be as follows: The cladosiphonic character is the anatomical expression of the dominance of the axis in the shoot. Here the leaf trace is merely an external appendage on the stele, which is hardly disturbed by its insertion. This type is seen in certain small-leaved pteridophytes. The phyllosiphonic character, on the other hand, is the anatomical expression of the dominance of the leaf over the axis in the shoot. Here the insertion of the vascular supply of the leaf profoundly disturbs the

vascular arrangement in the axis. It is characteristic of certain large-leaved pteridophytes, and is seen also generally in seed plants.

It is a fact of importance that, in the individual life, the one or the other type is usually constant; but in certain ferns the progression may be traced from the cladosiphonic in the young plant to the phyllosiphonic in the mature, thus suggesting a similar progression in descent, viz., that the large-leaved phyllosiphonic ferns were derived from a smaller-leaved cladosiphonic stock. Of the converse, viz., the progression from the phyllosiphonic to the cladosiphonic state in the individual life, I know of no example among the pteridophytes, though it is true that there is some approach to it in the Marsileaceæ. Thus the anatomical evidence indicates a probability that, even in large-leaved ferns, the cladosiphonic was the primitive type; but that the phyllosiphonic, once initiated, is as a rule maintained; this is shown by its persistence in the seed plants, even where the leaf has been reduced in size.

Having thus gained a valuable sidelight from anatomy, we may now return to our central question, of the initial relation of leaf to axis. Of the three theories already noted, the theory of overtopping as applied to the origin of the leaf, may in my opinion be dismissed, as it is not based upon comparison of nearly related forms, while the sympodial development of a dichotomous system, on which it is founded, is a general phenomenon of branching, restricted neither to leaves nor to the sporophyte generation. As to the other two, the facts whether of external form or of internal structure seem to me to indicate this conclusion: that the strobiloid condition was primitive for certain types, such as the Equisetales, Lycopodiales and Sphenophyllales; that in them the leaf was from the first a minor appendage upon the dominating axis; and anatomically they have never broken away from the cladosiphonic structure, which is the internal expression of their microphyllous, strobiloid state. That the Filicales and also the Ophioglossales were probably derived from a microphyllous strobiloid ancestry, and achieved the phyllosiphonic structure as a consequence of leaf enlargment, this being the derivative rather than the primitive condition; its derivation is even illustrated in the individual life of some ferns. From the Filicales the phyllosiphonic structure was probably handed on to the seed plants, and by them retained, notwithstanding the subsequent leaf reduction which followed on their adaptation to an exposed land habitat. Thus a strobiloid origin may be attributed to all the main types of vascular plants. It seems to me to harmonize more readily with the facts than any phytonic theory does.

A prototype, which was probably a prevalent, though perhaps not a general, one for the pteridophytes, may then be sketched as an upright, radial, strobiloid structure, consisting of a predominant axis, bearing relatively small and simple appendages. On our theory the origin of those appendages in descent would be the same as it is to-day in the individual development, viz., by the outgrowth of regions of the superficial tissue of the axis to form them. The axis would preexist in descent, as it actually does in the normal developing shoot. The origin of these appendages may have occurred independently along divers lines of descent, and the appendages would in that case be not homogeneous in the strict sense. Thus there would be no common prototype of the leaf, no morphological abstraction, or archetypic form of that part. More than one category of appendages might even be produced on the same individual shoot, differing in their function on their first appearance. Such has perhaps been

the case in the calamarian strobilus, where the leaf tooth can not be readily homologized with the sporangiophore. These suggestions will suffice to indicate how elastic a strobiloid theory is, and how its application will cover various types of construction, even such as are shown by the most complex cones of pteridophytes.

From the comparison of living species there is good reason for thinking that all the primitive leaves in certain types, such as the lycopods, were sporophylls, and that a subsequent differentiation took place, by abortion of the sporangia; thus a sterile vegetative region became defined from a fertile upper region. It may be a question whether this origin by sterilization of sporophylls is applicable to foliage leaves at large. Nevertheless, analogy, not only with other vascular plants but also with the bryophytes, suggests that a similar differentiation of a sterile from a fertile region has been a general phenomenon in the neutral generation. At first in the simpler pteridophytes these regions were essentially similar to one another in form, as is still seen to be the case in some lycopods. Later, however, the sterile and fertile regions took divergent lines of development in accordance with their difference of function. The differentiation reaches its climax in the higher flowering plants. The inflorescence, or flower, on this view, though produced later than the vegetative region in the individual life, embodies the more primitive parts, viz., those which bear the sporangia and spores. The vegetative region is in its origin mostly, if not wholly, secondary. The physiological reasonableness of this view is too obvious to need insistence. As the self-nutritive powers of the gametophyte fell off in the adaptation to the land habit, the nutritive function was taken up by the new vegetative system thus intercalated between sexual fusion and spore production.

This is in brief outline the strobiloid theory of the shoot in vascular plants, as arising out of the facts of antithetic alternation. It will be seen that it is essentially in harmony with the view of Braun, upheld also by Sachs, that the shoot is the real morphological unit, of which leaf and axis are correlative parts. Those who adopt it will find their position simplified in regard to another question which has recently taken afresh a prominent place in morphological discussions, viz., the theory of cortication (Berindungstheorie). It is held by Potonié, and a similar view was also maintained by Celakovsky, that the stem has centrally an axial nature, peripherally a leaf nature. The primitive axis (Urcaulom) acquires in the course of generations, by coalescence with the basal parts of its primitive leafy appendages (Urblätter), a mantle,—a 'Pericaulom.' This is what we commonly designate the cortex, which is thus regarded as not being axile in origin, but foliar. In accordance, however, with our strobiloid theory we may presume that, as is seen in some of the bryophytes, the simple sporophyte consisted originally of a central region—a primitive stele—and a peripheral region, a primitive cortex. From the latter sprang the appendages, as superficial outgrowths, just as at the present day the leaves originate upon the cortex of the axis. The cortex in such cases would be, from the first, part of the primitive axis, and the outgrowths processes from it. The primitive cortex from which the appendages sprang may remain a continuous, undifferentiated band, as it actually does appear in the vast majority of leafy sporophytes; or it may be in certain cases more or less clearly marked off into regions surrounding the insertion of the individual leaves. But in the fact that these special cases exist I see no sufficient foundation for the view that each leaf is, in shoots at

large, connected with a definite area of extended leaf-base; and still less for the theory that in vascular plants the cortex originated from such coalescent leaf bases. Our theory of the strobilus would, indeed, presuppose that close relation of cortex and appendage, and absence of limit between them, which is so common a feature in vascular plants; and furthermore, it will readily cover the facts where the cortex is delimited into definite areas round the leaf bases; but it does not recognize any necessity for generalizing from such cases of special delimitation that the cortex is foliar in its origin, in shoots of vascular plants at large. It would be more ready to suggest the converse, viz., that the leaves were cortical in their origin, as, indeed, they are in the ontogeny.

Discussions such as these on phytonic theory, or theory of cortication, are liable to develop into mere scholastic contests. They originated in the present case in the use of terms in an unprecise sense, and the subsequent attempt to attain precision. Both these theories have proceeded from the assumption that the 'leaf' is an abstract entity, distinct from the stem. Difficulties arise when the attempt is made to carry out that distinction sharply in practise, for this is nothing less than the attempt to define precisely things which in point of fact appear neither uniform nor precise in nature. The strict definition of terms used in morphological science is doubtless in itself a desirable thing; but it must be so conducted as to harmonize with the facts of individual development, while at the same time it must not violate evolutionary probability. As a matter of fact, neither in the mature state nor in the ontogenetic or phylogenetic development of the leaf does the structure suggest its sharp delimitation from the axis as a general feature in the shoots of ordinary vascular plants.

My present position with regard to the phytonic theories and the theory of cortication is frankly destructive; for in the first place, if the evidence from the gametophyte generation be discounted, the facts of segmentation in the sporophyte are of the slenderest; further, I do not think that morphological insight will be advanced by attempts to define precisely the limits of the parts of the vascular shoot; it seems more in accordance with nature to accept for vascular plants the view of Braun and of Sachs, that the shoot is the original unit. What is first urgently required, in order to decide such questions, is the correct recognition of the phyletic lines which eventuated in the various appendages as we see them. Then may follow definitions of the parts, which may or may not succeed in assigning their strict limits. When this is accomplished a terminology may follow which shall segregate parts which have had a separate phyletic origin. Thus an evolutionary morphology of the shoot would be built up. But it is useless to accept the thesis merely in the abstract that the basis of morphology must be in phylogeny; the principle must also be put in practise, and be ultimately reflected in our methods, and in the definition of our terms.

A step in this direction will be the recognition that at present the word 'leaf' is loosely applied; it is, indeed, a temporary makeshift borrowed from colloquial language, and used in a descriptive rather than in a strictly scientific sense. It designates collectively objects which have, it is true, formal and functional, and even topographical, features in common, but have not had the same phyletic history. There is every probability that the word 'leaf' will continue to be used in this merely popular sense.

This position, with its conservative use of terms fitting awkwardly upon advanc-

ing phyletic ideas, can only be properly understood by glancing back at the history which has produced it. So long as species were regarded as the individual results of creative power, the complexity and variety of their form were relegated to the arcana of the divine mind, and organic nature presented the aspect of a series of isolated pictures; any similarity which these might show was to be regarded as indicative of the underlying divine plan. Now that species have been threaded together by evolutionary theory into developmental sequences, they, like the ribbon of a cinematograph, present phyletic history to the mind with all the vividness of a living drama. While monophyletic views held the field, this seemed comparatively simple; but the conclusions thus arrived at in plant morphology were often palpably improbable. Such difficulties, together with the substantiation of examples of parallel development on a sound comparative basis, led to the modification of monophyletic views, and opened the way for less cramped conceptions. It is now customary to contemplate the plural origin of such leading features as sexual differentiation, foliar development, heterospory, the seed habit, as well as a host of minor characters. On such examples we base a general belief that similar structures may be arrived at by divers evolutionary routes. It is this conception of polyphyleticism that we must make clear in our descriptions, if not even in our terminology.

It will be objected that to carry through a method of designating by the same term only such parts as are shown to be of common descent would produce unwieldy results. Doubtless this is true, but in the terminology of a science it is not so much convenience, as truth and clearness which should be the aim. The choice is open to us either to make the terminology strictly phyletic throughout, which would certainly be cumbrous, though it would reflect the true position, or, putting phyletic distinctions in the background, to use terms in a more or less comprehensive sense, even grouping together things which we know to have been distinct in phyletic origin. Such a comprehensive sense is conveyed by the expression 'homology of organization,' which, as Goebel points out, 'has only to do with phylogeny in so far as it recognizes a common capacity for development derivable from undifferentiated ancestors.'*

This is, indeed, a collective term for the results of parallel development; it suffers from the danger of suggesting some ideal type, or pattern, towards which evolution has tended.

For my own part, I think it matters little what our terminology be, or what the separation of categories of parts, provided we attach clear meanings to the words we use, and select those words as naturally conveying that meaning. For instance, if we fully realize that the word 'leaf' is used in a sense which is not phylogenetic, but merely descriptive of those lateral appendages on the shoot which are produced exogenously, and in acropetal order, then let it remain, ranking as an expression of 'homology of organization.' But the appendages thus included may for clearness be conveniently divided into 'phyllomes' on the sporophyte and 'phylloids' on the gametophyte, as indeed I suggested some years ago. Nevertheless, these again are not phyletic unities; they include parts with distinct histories which have already been recognized in the gametophyte, while for the sporophyte a more advanced state of the science will probably provide definitions. Meanwhile we consent to a compromise in grouping these together; but the only condition upon which this can be safely done is the clear knowledge that this is a compromise by which we secure a cer-

* 'Organographie,' English edition, p. 19.

tain convenience of description. Moreover, the acceptance of this compromise must not be understood to grant free license to argue from one to another of the forms included, as though they were equivalents; what has resulted in one line of descent can at best only throw a side light on what has happened in another distinct line, and in proportion as the lines involved in a comparison are more remote from one another, their comparison assumes more and more the character of a mere analogy. The danger which our compromise brings with it is that this will not be clearly kept in mind. At all hazards the strict phyletic view should underlie all present morphological discussion, notwithstanding that, for mere convenience, that view may not be clearly reflected in the classification of the parts. This makes me hope that the compromise is only a temporary concession, and that it will give way ultimately to the demands which a more detailed knowledge of descent is sure to bring.

It is well, however, in connection with discussions such as these, to impress upon the lay public that all evolutionary theories are, like other scientific theories, hypotheses incapable of complete proof. No one will appreciate this more fully than biological investigators themselves, for they are in the best position to know how insufficient the evidence actually is, and how liberal a use has to be made of the imagination in bridging over the wide gaps in the series of known forms. The details of a story thus constructed depend so largely on comparative opinion, and in so slight a degree on positive demonstration, that the history as told by competent experts in comparative morphology may vary in material features. A little more weight allowed for certain observed details, or a little less for others, will be sufficient to disturb the balance of the evidence derived from a wide area of fact, and consequently to distort the historical picture. There is in truth no finality in discussions on the genesis and progress of organic life, or in the kaleidoscopic changes of opinion, since any new fact of importance will in some degree affect the weight accorded to others, and may vary the general result. It will be objected that conclusions which are so plastic are little better than expressions of personal taste; that the study of comparative morphology, is, therefore, calculated to dishearten its votaries, while the non-specialist public, which is compelled to take its information at second hand, will be bewildered, and will conclude that it is useless to pursue a subject which shows so little stability. But, on the other hand, those who follow the progress of morphology with sympathetic care will take heart when they compare its present position with that of a generation ago; it is encouraging to think that it is little more than half a century since the history of the life cycle of a fern was first completed. In some sixty years a vast array of kindred facts has been acquired, and a theoretic structure is being raised upon them which, though still protean, is gradually acquiring some settled form. Never has the advance of morphological thought been more rapid than at present. The support of the facts of alternation from the unexpected quarter of minute cytology has been one of the most striking features in the recent history of our science. The discovery of spermatozoids in the cycads and Gingkoaceæ has filled in a gap in the story of evolution which all followers of Hofmeister must have felt. But in no field of morphological research has investigation been more amply rewarded than in paleophytology. The luminous facts derived from fossils are shedding fresh light on obscure problems, such as the origin of the seed habit, and helping us to locate such difficult groups as the Psilotaceæ and

Equisetaceæ. When we regard these rapid advances, and truly estimate the influence they bring to bear upon morphological theory, we must surely congratulate ourselves on being devotees to a science which is very actively alive.

But at the same time the detached cynic may find in the methods of plant morphologists, or still more sometimes in their want of method, food for much critical remark. And if he put his finger upon one mental process which more than another has introduced discord, it would, I think, be 'assumption.' It may be that our science is not worse than others in this respect; but I am very sure that arguments based upon ill-founded assumption have put back the progress of morphology more than anything else in our discussions. Any one can find examples for himself in the literature; some of us in our own writings. It remains for us who tread the difficult path of morphological theory to beware lest we neglect those warnings with which its course is so plentifully strewn; for it is just as much the duty of a scientific man to avoid blurring the issues for others by faulty argument, as it is to attempt to make clear to them what he himself believes to have been obscure.

F. O. Bower.

University of Glasgow.

SCIENTIFIC BOOKS.

The Belgian Antarctic Expedition. Resultats du Voyage du S. Y. Belgica en 1897, 1898, 1899, Zoologie. Nématodes libres. Dr. J. G. de Man. April 15, 1904; 51 pp., 4to, pl. i–xi. *Bryozoa,* by A. W. Waters. February 15, 1904; 114 pp., 4to, pl. i–ix.

The report on the free nematodes considers four fresh-water forms truly Antarctic, and six marine species collected in the Magellanic region, of which, however, one had been originally described from South Georgia. Three of the Antarctic forms are new, one being supposed to belong to a new subgenus (*Plectoides*); the other form, a *Dorylaimus,* is too young for determination. The other three belong to the genera *Mononchus* and *Plectus.* This little group has a special interest in being the first known fluviatile forms from the Antarctic continent. All the species are treated at great length and profusely illustrated.

We learn from Water's report that 86 species of Antarctic bryozoa were collected; on one occasion 55 species were obtained at one haul of the tangles. Eleven others from the extralimital subantarctic waters are also considered.

Of the 86 species and varieties of Antarctic origin 57 are new, many of which are very closely related to already known northern forms.

Of the Chilostomata only seven are known from the northern hemisphere, all of which are also known in the fossil state. Three species are cosmopolitan and also Arctic. But little support is given to the 'bipolar' theory by the Bryozoa considered in this paper. The specimens of *Hornera lichenoides,* long since reported as brought from the Antarctic by Sir James Ross, there is much reason to believe did not come from that region, as they agree with Arctic and do not agree with Antarctic specimens of that genus. *Orthopora, Cellarinella* and *Systenopora* are described as new genera, all of which are Antarctic. A new species of *Alcyonidium* and seven new *Cyclostomata,* with seven others previously known, and one indeterminate, complete the enumeration.

W. H. Dall.

Smithsonian Institution.

SCIENTIFIC JOURNALS AND ARTICLES.

In the *Botanical Gazette,* for September, M. A. Chrysler has written upon 'The development of the central cylinder of Araceæ and Liliaceæ,' developing in these groups the recent stelar theories and reaching the general phylogenetic conclusion that monocotyledons are derived from dicotyledonous ancestors.—D. S. Johnson has given an account of 'The development and relationships of Monoclea,' a Jamaican liverwort.—W: C. Coker has writ-

ten a brief account of 'The Spores of Certain Coniferæ,' describing certain features of the male gametophyte and the megaspore.—G. J. Peirce has published a preliminary notice of 'Artificial parasitism,' giving an account of his experiments in growing a pea on a plant of horse bean, the pea blossoming and setting seed.—Albert C. Herre records the remarkable growth of the thallus of *Ramalina reticulata*.

PROFESSOR BURTON-OPITZ, of Columbia University, has undertaken the charge of the abstracts of American publications on the relations of medicine and chemistry for the *Biochemische Centralblatt*. Authors are requested to send him reprints.

SOCIETIES AND ACADEMIES.

CLEMSON COLLEGE SCIENCE CLUB.

THE first regular meeting of the club for the year was held on September 29, at 8 P. M., in the lecture room of the Electrical Laboratory of Clemson College. Professor W. M. Riggs discussed 'Recent Advances in Electrical Engineering.' Dr. R. N. Brackett presented a paper on 'The Present status of the Nitrogen Problem.'

HAVEN METCALF,
Secretary.

DISCUSSION AND CORRESPONDENCE.

VARIÆ AUCTORITATIS.

TO THE EDITOR OF SCIENCE: In looking over the numbers of SCIENCE on my return from my summer's work in the Rocky Mountains I find in your issue for August 12 a communication from Dr. C. R. Eastman entitled 'Variæ Auctoritatis,' in which he complains of the carelessness of scientific writers in citing ancient authorities, and brings me in at the head of his list of offenders quoted.

While agreeing with Professor Eastman in the general principle laid down by him, his remarks with reference to me seem to flavor of a certain disingenuousness.

He refers to my paper on 'The Theories of Ore-deposition Historically Considered,' in which, on page 2, I am made to say that 'It is said that as early as Origenes, 600 B. C., etc.,' whereas Origenes flourished about 200 A. D. Dr. Eastman very courteously pointed out this error in a personal letter to me in June last, and in reply I stated that this was something that had escaped my notice in proof-reading, and that the sentence should have read, 'Thus it is said by Origenes that as early as 600 B. C., etc., etc.,' at the same time referring him to my authority, Professor K. von Zittel, who, on page 3 of his 'History of Geology and Paleontology' says, 'Origenes reports of Xenophanes of Colophon that he had observed sea shells on mountains, etc., etc.'

With regard to his second criticism, I am unwilling to admit any error in my words as published. In opening my section on the 'Scientific Period' I remark that 'Up to this time (the close of the eighteenth century) even the name geology had hardly been recognized, natural history or mineralogy being the title usually given to works that treated of it.' Later, in speaking of De Saussure's work I say, 'He also appears to have been the first to use the name geology for *his* science.' Dr. Eastman says that my statement is incorrect, inasmuch as Richard de Bury spoke of Geologia as the 'earthly science' in 1344. That this learned prelate, or some other philosophical writer of an even earlier date, may have used the word does not disprove the correctness of my statement that De Saussure was the first (geologist) to use this term for *his* science. My statement does not necessarily imply that he was the first man who ever used the word, and I should have considered it a useless waste of time to have searched all ancient literature to find out by whom it was first used, for I do not feel at all sure that de Bury is entitled to that credit.

S. F. EMMONS.

THE SWALLOWING OF STONES BY SEALS.

TO THE EDITOR OF SCIENCE: So far as I am aware no satisfactory reason has been advanced for the swallowing of stones by seals, and this statement may probably be extended to other animals. They are not taken in for ballast, for the empty seals keep down as easily as the others; they are not swallowed for the purpose of grinding up food, for they occur in the stomachs of nursing pups; they are not

to allay the irritation caused by parasitic worms, since the two are by no means found together; they are not taken in with food, not merely because they are found in the stomachs of young seals, but in those adults that have fed on squid caught in the open sea. On page 68, Vol. III., 'Report of Fur Seal Investigation,' it says: "It is evident that these things are not swallowed haphazard, but are selected with considerable care from among the articles strewn along the shore, and that a preference is exhibited for rounded objects. This is shown by the fact that, as a rule, only articles of one kind are found in one stomach, although seals do not discriminate between fragments of barnacles and fragments of gastropods. Moreover, pebbles of serpentine and chalcedony are now and then found on the hauling grounds under conditions indicating that they were brought there by the seals, while the pup seen gathering pebbles on Lukanin did so with great care, by no means taking the first that came to hand. The most striking example of this discriminative selection is, perhaps, shown by the pup which had swallowed a buckshot, while the chance of finding such a thing must be, at a guess, about one in a million."

Furthermore, it may be said that as the fur seal regurgitates bones and other indigestible things, the supply of stones must be renewed from time to time.

That there is any connection between the presence of stones and the presence of a gizzard does not follow. F. A. Lucas.

Brooklyn Institute Museum.

ANIMALS AT ROME IN ANCIENT TIMES.

Since the publication in Science (No. 506) of a short article entitled 'Ancient Natural History Lore,' the attention of the writer has been called to an interesting essay on a kindred subject by Countess Cesaresco. It is to be found in the August number (1904) of the *Contemporary Review*, under the title of 'Animals at Rome,' and presents a tolerable conception of the state of natural history amongst Romans of the Augustan age.

A work that was highly popular from the third century onward, and regarded as a standard authority on zoology, though comparatively little known at the present day is Ælian's treatise on the 'Nature of Animals.' The fifteenth book contains the earliest mention in history of the use of the artificial fly, and gives particulars of other modes of fishing in vogue during the olden time.

C. R. E.

SPECIAL ARTICLES.

ORNITHOLOGICAL NOTES FROM THE NEW YORK ZOOLOGICAL PARK.

A number of common terns (*Sterna hirundo*), least terns (*Sterna antillarum*), black skimmers (*Rhynchops nigra*) and laughing gulls (*Larus atricilla*) have recently been hatched from eggs in an incubator and reared in the New York Zoological Park. The eggs were all collected on the coast of Virginia.

Some interesting observations have been made for two seasons in connection with these birds, of which certain facts possess a special value and conclusiveness on account of the absolute isolation of these young sea-birds from adults of their species.

The sight of small but entire fish excites a newly-hatched black skimmer much more than does macerated fish, but the reverse is true of the terns until after the first week. Half-boiled and macerated fish does not quite take the place of what the parents of the terns would provide, but fish regurgitated by wood ibises after being held in the crop for two hours is a perfect substitute.

All the birds which were hatched in my experiments refused salt water, for both drinking and bathing, when fresh water was provided.

The remarkable disparity in the length of the upper and lower mandibles of the black skimmer is distinctly foreshadowed in the embryo of about the beginning of the third week.

The call, flock and alarm notes of all four species are wholly instinctive; neither taught by the parents nor learned by imitation. The first class of notes are uttered at the instant when the egg-tooth pierces the shell. The utterance which I have called the *flock* note differs decidedly from the call of the young for food, and is not uttered until the bird is

a day or two old. When several are together, this note seems to attract them to each other, while the ordinary call-note does not, and the alarm note has the very opposite effect.

There is absolutely no *instinctive* fear of man, cats, dogs, hawks or other objects, if these enter quietly into the environment of the birds, but a sudden shadow or unusual noise causes them to utter the characteristic cries of alarm (rarely), or usually to perform certain acts—wholly instinctive—which have for their object an escape from some supposed danger. Under such conditions the terns, which are not so protectively colored as the skimmers, take time to run to a near-by corner or shadow before squatting, while a skimmer crouches instantly, and with two or three sidewise flicks of feet and legs almost buries himself.

The act of pecking is instinctive to a certain extent, but is acquired very slowly and, at first, imperfectly, in this way. By imitation it is learned quickly and is performed successfully within a few minutes.

The art of flying is wholly instinctive, all the species learning the use of their wings as soon as the primaries are large enough to support them.

The characteristic method of feeding, which has given their name to the skimmers, begins to be apparent after three or four weeks, the birds then taking a piece of fish from one's hand with a quick run past, holding the bill so low that it almost touches the ground. A skimmer two months old 'skimmed' often through a small pool of water in its enclosure.

At first the young skimmers are very weak and helpless and are not able to compete with terns of the same age in getting their share of fish, but after about forty days they obtain the upper hand and soon become so aggressive and domineering that they have to be separated and confined with individuals of their own species.

One interesting result attained is the successful establishing of a colony of laughing gulls in the zoological park. These birds require three years to assume the adult breeding plumage, and for two seasons some twenty-five birds have made their home in the park, without the loss of an individual. Several of their number migrated south in the fall of 1903 and returned the following spring. Thus the wonderful homing instinct of these birds has been controlled and extended by bringing the eggs or the very young birds to a new locality, and though the park individuals doubtless mingled with others of their kind, possibly even associating with their actual parents, yet the *Heim Liebe* overcame all other attractions.

With the erection of the two new bird houses now almost completed, opportunity for experiment and observation upon the collections of the society will be undertaken, on a scale of elaborateness and thoroughness hitherto impossible.

C. WILLIAM BEEBE.
NEW YORK ZOOLOGICAL SOCIETY.

HEIGHT MEASUREMENTS OF THE AFRICAN PYGMIES.

Apropos of the presence of the group of African pygmies from the Wissmann Falls region in the exhibit of the department of anthropology at the World's Fair, it may be pertinent to summarize the height measurements given by various modern travelers who have recorded their observations. Unfortunately, the circumstances under which some of these observations were made were not con-

Observer.	Time.	Place.	No. Adult Males.	Height, Average.
Du Chaillu	1863	1° N. 11° E.	1 young man.	4 ft. 6 in.
Schweinfurth	1869	1 N. 23 E.	6	4 ft. 10 in.
Wissmann and Wolff	1886	5 S. 24 E.	Not given.	4 ft. 7 in.
Stanley	1888	1 N. 29 E.	1	4 ft. 6 in.
Johnston	about 1900	1 N. 29 E.	Not given.	4 ft. 9 in.
Belgian Officers	about 1900	1 N. 29 E.	5	4 ft. 8 in.
Verner	1897	6 S. 22 E.	50	4 ft. 8 in.
Verner	April, 1904	6 S. 22 E.	15	4 ft. 10 in.
Verner	Aug., 1904	St. Louis.	5	4 ft. 10 $\frac{8}{10}$ in.

over the axis, and will favor some phytonic theory; those who hold the smaller-leaved forms to be the more primitive will probably adopt a strobiloid theory of origin of the leafy sporophyte. I propose to offer some remarks on the relative probability of these alternative views.

If large-leaved prototypes be assumed generally for vascular plants, this naturally involves a widespread reduction, since small-leaved forms are numerous now, and have been from the earliest times of which we have any record. Reduction is a ready weapon in the hands of the speculative morphologist, and it has often been used with more freedom than discretion. But reduction should never be assumed in order to meet the demands of convenience of comparison, nor as a cover for doubt. The justification of a view involving reduction must be found in its physiological probability in the case in question, and this should be backed by comparisons of form and of anatomical structure; the conclusion should also be in accordance with the paleontological record. All suggested cases of reduction where such justification is absent should be looked upon as doubtful.

Convincing evidence of reduction of leaf complexity in an evolutionary sequence, supported on all these grounds, has been adduced in the progression from ferns, through cycado-filicinean forms, to the cycads; and it applies with special force in the case of their sporophylls. Ferns, which are essentially shade-loving and typically zoidiogamic, or amphibious, may be understood to have given rise to the cycado-filices, and cycads, which are more xerophytic, and show that essential character of land plants—the seed habit. Not only is such a progression physiologically probable, but it is supported by paleontological evidence, as well as by detailed facts of anatomy, and of reproductive morphology. The case for reduction of leaf complexity seems to be here fully made out, and somewhat similar arguments will also apply for other types of gymnosperms.

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interest to the subject which it would otherwise lack.

Physical geology begins with the solar nebula and the genesis of the earth-moon system. The harmonies of the solar system compelled the immortal Kant and the ever-living Laplace to seek the origin of the planets, the sun and the other stars in heterogeneous nebulas which they supposed to have condensed about one or several nuclei. Every attempt to devise an essentially different hypothesis has failed, and every history of the globe which begins after the birth of the planet is unsatisfying. In the drama of the universe there must have been pre-nebular scenes, but of these we have as yet no inkling. The nebular hypothesis, as its authors propounded it, explains the similarity in the composition of the members of the solar system which is indicated by the analysis of meteorites and by the spectroscope, though the facts thus revealed were unknown to Kant and Laplace. It is also compatible with and accounts for the heterogeneity in the composition of the earth manifested in the actual asymmetric distribution of oceans, mountain ranges and anomalies of gravitational force, as well as in the curiously local occurrence of certain ores (such as those of tin and mercury) and in the predominance of certain alkalies among the rocks over wide areas.

This heterogeneity, however, is of a small order of magnitude. The general dependence of gravity on latitude, the nearly spheroidal shape of the earth and other phenomena show that the distribution of density is nearly symmetrical, while the divergence of the spheroid from the figure characteristic of a fluid of the same mean density and mass as the earth demonstrates that the interior layers of equal density are oblate. These and similar facts are consistent with and are strong evidence for the hypothesis that the globe has been fused at least to a considerable depth from the growing surface of the gathering nebulous mass. Nevertheless, Houghton, and more recently Professor Chamberlin, have supposed that the accretion of nebulous matter was so slow that the heat of impact did not suffice to produce fusion. The hypothesis of superficial fusion is not incompatible with the minor heterogeneity pointed out above; for the laws of diffusion in viscous fluids give proof that sensibly perfect homogeneity could not be produced even in 50,000,000 years throughout a body of liquid originally heterogeneous and possessing a tenth of the mass of the earth. On the other hand, there is no known ground other than mere convenience for supposing an original homogeneity either of the nebula or of the earth.

The problem of the distribution of density in the earth is one of the most important in all geophysics. It is as significant for geodesy and terrestrial magnetism as for geology. That Laplace's empirical law represents it approximately is generally acknowledged, but it appears substantially certain that this is merely an approximation without theoretical value. Only extended researches, however, can replace it by one better founded.

The solidity of the earth is now very generally accepted, though Descartes's hypothesis of its fluidity, invented to satisfy his erroneous theory of vortices, died hard. Lord Kelvin showed from tidal phenomena that the effective rigidity of the earth is about that of a continuous globe of steel. Professor Newcomb pointed out that the Chandlerian nutation leads to the same conclusion and an almost identical value of the modulus of rigidity, and Professor George H. Darwin demonstrated that, if the earth is a viscous liquid, its viscosity must be some 20,000 times as

great as that of hard brittle pitch near the freezing point of water. From the point of view of modern physical chemistry and in consideration of Professor Arrhenius's opinions, the matter requires further consideration. In particular it is most important to know whether the earth is substantially a crystalline solid or an amorphous substance, for many modern physical chemists consider amorphous matter as liquid. This opinion is far from being established, however, and recent experiments by Mr. Spring show that mere deformation at ordinary temperatures, attended by only a very small absorption of energy, suffices to convert crystalline metals into substances exhibiting characteristics of amorphous bodies. Since Nordenskiöld's great discovery of large masses of terrestrial iron, or, rather, nickel steel, in Greenland, and the wide distribution since proved for similar metal imbedded in igneous rocks, a great amount of evidence has accumulated that a large part of the earth is composed of material indistinguishable from that of metallic meteorites. Meteoric iron is of course a highly crystalline material.

It is a very striking fact that the mean rigidity of the earth is about that of steel, for the only substance likely to occur in extensive continuous masses and displaying such rigidity at ordinary temperatures and pressures is steel itself. Nevertheless, the conclusion can not yet be drawn from the resistance to deformation displayed by the earth, that it is chiefly composed of steel. Elastic resistance is known to be a function both of pressure and of temperature, and until this function has been determined by theory and experiment, the bearing of the evaluation of rigidity by tidal action can not be ascertained.

Having shown the earth to be a solid globe, Lord Kelvin calculated its age from one of Fourier's theorems, assuming for purposes of computation an initial temperature of 7000° F. (nearly 3900° C.) and that the thermal diffusivity of the earth is that of average rock. These assumptions, with the observation that the temperature near the surface of the earth increases at the rate of 1° F. for every 50 feet of depth, lead to an age of 98,000,000 years; but on account of the uncertainty as to conductivities and specific heats in the interior, the conclusion drawn by Lord Kelvin was only that the time elapsed since the inception of cooling is between 20 and 400 million years.

Clarence King subsequently took a further important step on the basis of data determined at his request by Professor Carl Barus on the volume changes which take place in diabase during congelation, and on the effects of pressure in modifying the melting and solidifying points. Assuming that the earth can never have had a crust floating on a liquid layer of inferior density, computation leads him to 24 million years as the maximum period for the time since superficial consolidation was effected, provided that the superficial temperature gradient and conductivity are correctly determined.

These researches, together with Helmholtz's investigation on the age of the solar system, which is incomplete for lack of knowledge of the distribution of density in the sun, have had a restraining influence on the estimates drawn from sedimentation by geologists. Many and perhaps most geologists now regard something less than 100 million years as sufficient for the development of geological phenomena. Yet the subject can not be regarded as settled until our knowledge of conductivities is more complete. An iron nucleus, for example, would imply greater conductivity of the interior and a higher age for the earth than that computed by King, though probably well within the range explicitly al-

lowed by Lord Kelvin in view of the uncertainty of this datum.

The researches of Kelvin and Darwin, supplementing those of Kant and others, have left no doubt that the moon was formerly closer to the earth than it now is, and that the rotation of the latter was more rapid, involving a greater ellipticity of the meridian than it now shows. In a fluid or Cartesian earth the change of figure might have produced little effect on the structure of the planet. If the earth is chiefly a mass of crystalline nickel steel, it is very possible that such a change in the figure of equilibrium might rupture it. Since the epoch at which the earth rotated in 5 hours 30 minutes, the polar axis must have elongated by several per cent., most of it before the time of rotation was reduced to 11 hours.* Were the earth chiefly composed of forged steel, such elongation might be produced by plastic deformation; but meteoric iron is rather comparable with cast iron, or better still, with relatively brittle, unforged cement steel, and might break.

Now it is an indubitable fact that a majority of the outlines of the great oceanic basins and of the chief tectonic lines of the globe, lie nearly on great circles tangent to the Arctic Ocean and to the Antarctic continent.† These lines, or most of them, are of extremely high geological age, their main features having found expression as early as the oldest known fossils and in some cases still earlier. It appears to me very possible that these fundamental ruptures of the globe were due to the change of figure attendant upon diminution of the earth's period of rotation. Their symmetrical disposition with reference to the polar axis is unquestionable, as well as the fact that they penetrate to great depths. They must be due to some tremendous force acting axially, which actually altered the ellipticity of the meridian, since these fissures could not have been formed without modifying the shape of the globe, and the only known disturbance of this description is the change of figure referred to. On the other hand, were the earth homogeneous, such ruptures would be expected to have as envelopes small circles in latitude 45° instead of at about latitude 70°. But since the earth is not homogeneous, this discordance does not invalidate the suggestion.

Be this as it may, upheavals, subsidences and attendant contractions have been in progress throughout the whole of historical geology or the period within which fossils afford a guide to the succession of strata. The so-called contractional theory has shown itself wholly inadequate to account for the amount of deformation traceable in the rocks of the globe, nor has the extravasation of igneous rock been sufficient to account for the phenomena. To me the earth appears to be a somewhat imperfect heat engine in which the escape of thermal energy is attended by the conversion of a part of the supply into the vast amount of molar energy manifested in the upthrust and crumpling of continents. The subject will probably turn out to be accessible mathematically after certain experimental determinations have been made, and I shall return to it presently.

Orogeny or mountain building is a mere

* Compare Thompson and Tait, 'Nat. Phil.,' § 772, where the rotational period and eccentricity are given for a fluid of the mass of the earth and possessing its mean density. When the period is 5h. 30m., this table gives the data for computing that the polar axis has a length equal to 0.95 of the length which it has when the period is a siderial day. For rotation in 10h. 57m. the polar axis is 0.99 times that for a day.

† In 1857 Professor R. Owen, of Tennessee, and, independently, Benjamin Peirce, called attention to the tangency of the coast lines to the polar circles (not to the coast lines of the arctic sea and the antarctic continent), each attributing the facts to the influence of the sun. In the first 'Yearbook' of the Carnegie Institution I failed to refer to these publications.

detail of the more general subject of upheaval and subsidence, but it exhibits problems of great complexity both from the experimental and from the theoretical points of view. There is no question that unit strains are often reached or even surpassed in contorted strata and in belts of slate, but the theories of elasticity and plasticity as yet developed are inadequate to deal with these strains in complex cases. An investigation on finite elastic and plastic strain is now under way in my laboratory and has made gratifying progress thus far; but this is not the place for detailed results. Something also has been done in the way of working out homogeneous finite strains in rocks, so that the general nature of joints, faults and systems of fissures and the mechanism of faulting is now fairly clear. The theory of slaty cleavage is a subject of dispute in which I have taken part. Few colleagues appear to agree with me that this cleavage is due to weakening of cohesion on planes of maximum slide, but I am not hopeless that my view will make its way to favor in time.

Seismology is a vast subject by itself, but one almost totally lacking in theoretical foundation. Seismological observations should afford the means of exploring the elastic properties of the earth throughout its interior, but the theory of the vibrations of a spheroid like the earth is not yet worked out. Meantime observations are being accumulated, but it can be foreseen that these will contribute little to elucidation until they include the vertical components of the vibrations as well as the horizontal ones. In other words, we must know the angle at which the wave emerges from the surface as well as its azimuth. The causes and conditions of earthquakes afford a separate topic of great interest. That some of them are of volcanic origin is evident; others appear to be due to paroxysmal faulting, yet there is very possibly a common underlying cause.

On no subject are opinions more divergent than concerning the origin and mechanism of volcanoes. To the ancients they were the mouths of the river Phlegethon. To those who adhere to the Cartesian doctrine they are communications with the liquid interior of the earth. Most geologists think of them as connected with hypogeal reservoirs of melted matter subsisting for indefinitely long periods of time. Finally it is conceivable that the lava may be extruded as soon as the melted mass has accumulated in sufficient quantity, somewhat as water may break through an obstructing dam after its depth reaches a certain value. The continual movements of the rocks show that they must be to some extent in a state of elastic strain, so that a given cubic mile of rock resists surrounding pressure in virtue both of its rigidity and of its compressibility. If that cubic mile becomes liquid, its rigidity is gone and the change of shape of surrounding masses may aid in its expulsion. Of course imprisoned gases, especially the 'juvenile waters' of Professor Suess, may also play a very important part in expulsion. But the more I have studied the matter, the less probable it seems to me that considerable bodies of melted lava can remain quiet for long periods of time in the depths of the earth. The influences tending to their expulsion would seem to be at a maximum immediately after the fusion of enough material to supply an eruption.

Relief of pressure is often invoked to explain fusion of lava, but it is not a wholly satisfactory cause. If a deep crack were to form, the rock at the bottom might melt indeed, but, as the crack filled, the pressure and the solidity of the source would be restored. To me, Mallet's hypothesis is more satisfactory, so far as the

explanation of fusion is concerned. Only those who have studied the minute evidence of mechanical action in mountain ranges can appreciate the evidence they present of stupendous dissipation of energy. This has not indeed been enough to fuse the rocks, but it is hard to conceive that it is always insufficient to furnish the latent heat of fusion to rocks already close to their melting point under the prevailing pressure. From this point of view, vulcanism is a feature of orogenic movement and it is to be looked for where relative motions are concentrated in zones so narrow that the local dissipation of energy is relatively intense. It is also possible that percolating waters, by reducing the melting points of rocks, sometimes bring about fusion without change of temperature. Such an hypothesis might fit the volcanoes of the Hawaiian islands where there is no known faulting in progress.

The physics of magmatic solutions is a great subject which is experimentally almost untouched, although a vast amount of geological speculation has been based upon assumed properties of magmas. It is only within a few months that even satisfactory melting-point determinations of those most important rock-forming minerals, the lime-soda feldspars, have been made. The feldspars are only one series of isomorphous mineral mixtures. Their study is fundamental and must be followed by that of the remaining class, *i. e.*, the eutectics. These, in my opinion, will lead to a rational classification of igneous rocks, themselves mixtures and incapable of logical description except in terms of standard mixtures, the eutectics.

It appears to me highly probable, for many reasons, that the magmas of the granular rocks are not liquids but stiff emulsions, comparable with modeling clay, the solid constituents (perhaps free oxides) being merely moistened with magmatic liquids. Such masses behave mechanically like soft solids; they display some rigidity and in them diffusion is reduced to a vanishing quantity. They may be ruptured and the (aplitic or pegmatitic) liquid portion may then seep into the cracks. Such a magma might be forced into minute fissures, as is the case when clay is molded to terra cotta articles and yet it would support permanently, on its upper surface, rocks of superior density. Only in such a magma can I comprehend the simultaneous growth of crystals of various minerals; for in a liquid not exactly eutectic, the formation of crystals must follow a definite order. Again, if banded gneisses and gabbros had been fluid, the bands would show evidences of diffusion which as a rule are absent or barely traceable in these rocks.

The relations between consanguineous massive rocks have occupied a large part of the attention of geologists for many years. At one time it was supposed that homogeneous liquid magmas might split up into two or more homogeneous magmas by processes of molecular flow due to differences of osmotic pressure. This process was called the differentiation of magmas. It has been shown, however, that these processes are so much slower even than heat diffusion, that they can not be efficient beyond distances of a few centimeters. For this reason, Mr. Teall,* who first suggested the application of the Soret process to account for differentiation, Professor Brögger† and others, have abandoned the hypothesis of differentiation on a considerable scale by molecular flow. Nevertheless, observations on laccolites and other occurrences leave no doubt that a single magma may solidify to different though consan-

* *Proc. Geol. Soc. London*, Vol. 57, 1901, p. lxxxv.

† 'Eruptivgesteine der Kristianiagebietes,' part III., p. 339.

guineous rocks. If the separation is not molecular, it is self-evident that it must be molar. The only molar currents readily conceivable in a body of magma are convection currents, and these, or even an equivalent mechanical stirring, would necessarily lead to fractional crystallization, a familiar process known even to the pupils of Aristotle, and which is almost unavoidable when mixed solutions solidify. This process is one of precipitation and is absolutely distinct from the differentiation (or more properly, segregation) of rock magmas, in which a single liquid is supposed to separate into two or more distinct liquids. The general conditions of the order of precipitation during fractional crystallization in accordance with the phase rule are by no means beyond the reach of discussion, and the able investigations of Messrs. J. H. L. Vogt and J. Morozewicz have a direct bearing on this subject.

A mystery which will assume greater importance as the accessible supply of coal diminishes is the origin of petroleum. There is much to be said in favor of the unpopular hypothesis of Mendeleef, supported by experiments on cast iron, that liquid hydrocarbons are due to the decomposition of the iron carbides of the terrestrial nucleus. Such vast accumulations of oil as exist on the Caspian and in the Caucasus seem incompatible with the hypothesis of animal or vegetable origin, although oils belonging to the same series as do the petroleums have been produced in the laboratory from organic materials. On the other hand, some meteorites contain hydrocarbons (which may themselves be due to the alteration of iron carbides) and there are geologists who infer that the petroleum may be derived from the mass of the earth itself.* If the origin of the oil is not animal or vegetable, the supply is very likely inexhaustible. More extended study of the connection between volcanic phenomena and the origin of asphaltic and other hydrocarbons is a desideratum.

Ore deposits themselves form the branch of geology which was earliest cultivated and which will never lose its interest so long as mankind remains gainful. Yet much remains to be done by experiment for the theory and practice of mining geology. The mechanism of the secondary enrichment of ores, particularly those of copper, detected by Mr. S. F. Emmons and enlarged upon by Mr. W. H. Weed, is being studied experimentally in the laboratories of the U. S. Geological Survey. A feature deserving careful experimental study is the osmotic separation of ores from their solutions by the wall rock. Many minutiæ of occurrence suggested that the walls of veins often act as a species of diaphragm or molecular filter and have a dialytic action on the ore solutions.* The origin of the ores themselves is still very obscure and will hardly be elucidated until more is known of the earth's interior. Sometimes they seem to be derived from adjacent rocks; in other cases conditions suggest that the rocks and the veins derive their metallic content from a common deep-seated source. Here, as in several other connections, Professor Suess's theory of 'juvenile waters' is very suggestive. It is held that many of the great iron deposits are due to magmatic separation. Deposition of lead ores by replacement of calcite is a known process, but takes place under unknown conditions. In some cases replacement of rock by ores appears to me to be alleged without sufficient proof. Pseudomorphosis is the only adequate test of replacement.

Erosion appears to be a subject which is capable of more exact treatment than it has received. Weathering and abrasion

* See H. L. R. Fairchild, *Bull. Geol. Soc. Amer.*, Vol. 15, 1904, p. 253.

* 'Min. Resources of the U. S. for 1892,' p. 156.

proceed with a rapidity which increases with the surface exposed per unit of volume.* Hence these processes lead to minimum surfaces. Therefore also the mathematics of erosion is essentially identical with that of capillarity.

Geological climates are as interesting to astrophysicists as to meteorologists and geophysicists. Messrs. Langley and Abbot appear to have evidences of recent variations in solar emanation. If these have been considerable in the course of the period of historical geology, light should be thrown upon them by the paleontology of the tropics. Variations in the composition of the atmosphere must have been very influential in determining both the mean temperature of the earth's surface and the distribution of temperature; but so also is the distribution of water. No theory of the glacial period seems generally accepted. Croll's theory is discredited. I have shown to my own satisfaction that the astronomical conditions most favorable to glaciation are high obliquity and low eccentricity of the earth's orbit,† but can not claim any extensive following. If I am right, it should be possible to obtain a definite measure of geological time in years as soon as the astronomers have completed the theory of secular variations in the planetary system so far as to be able to assign the lapse of time between successive recurrences of low eccentricity and high obliquity.

A most interesting observation, which promises much light on the past history of the globe, is that lavas and strata indurated by lavas retain the polarity characteristic of the locality in which they cooled.‡ The time may come when this will lead to determinations of the relative age of lavas, the duration of periods of eruption and possibly even absolute determinations of date.

Geology has long, and with some justice, labored under the reproach of inexactitude. As has been illustrated in the preceding pages, the science is still in the qualitative stage and almost wholly lacks the precision of astronomy. Even its most ardent students have seldom succeeded in ascertaining the quantitative relations between effects and operative causes and have been perforce content to indicate tendencies. Thus geological doctrine is far too much a matter of opinion, but this is hardly the fault of the areal geologist. The country must be mapped both for economic reasons and to accumulate a knowledge of the facts to be explained. Working hypotheses the field geologist must have, or he could not prepare his map; and he is only responsible for living up to the standard of knowledge of his time. He is continually face to face with phenomena for which physics and chemistry should account, though they have not yet done so, and must accept seeming probabilities where certainty is unattainable. So, too, Kepler's predecessors recorded facts and guessed at generalizations as best they might.

The physics of extreme conditions still awaits satisfactory exploration. The geologist turns to the physicist for help and in most cases meets with the reply: We can not tell. Astrophysics is in much the same situation. Astronomers know as little of the distribution of density in the stars or planets as do geologists. Real knowledge of the physics and chemistry of high temperatures would be as welcome to them as to us. After all, physical geology is the astrophysics of this, the only accessible planet. Geodesy, too, and terrestrial magnetism are waiting for the solution of geophysical problems. How much might be done, Lord Kelvin and Mr. George H.

* U. S. Geol. Survey, Mon. XIII., 1888, p. 68.

† *Amer. Jour. Sci.*, Vol. 48, 1894, p. 95.

‡ Brunhes and David. *Comptes Rendus*, Vol. 133, 1901, p. 153.

Darwin have shown; but there are many problems too broad and too laborious to be solved by individual effort, and these are as essential to the rounding out of the science of physics as they are to the development of geology and astrophysics.

In the brief review which precedes, I have endeavored to show that the history of the earth bristles with problems, few of them completely solved, though in many cases we have some inkling of the solution. This sketch has been drawn for the purpose of considering the strategy of a campaign against the series of well intrenched positions occupied by our great enemy, the unknown.

Generalizing the results of the sketch presented, it is easy to see that nearly all the problems suggested involve investigation of the properties of solids, or of liquids, or of the transition from one phase to the other. It is the business of the experimental physicist to establish linear relations; it is the occupation of the mathematical physicist to draw logical inferences from these relations. Each will have plenty to do in a methodical study of geophysics.

There can be no doubt that the character of the earth's interior and the physical laws which there prevail constitute the most fundamental object of geological and geophysical research, while the results of successful investigation would be immediately applicable at least to the moon and Mars. No one questions that enormous pressures and very high temperatures exist near the earth's center, while the quality of matter which constitutes the interior can not be satisfactorily determined until we know how substances would behave under extreme pressures and at temperatures approaching 2000° C. There is every reason to suppose that under purely cubical compression, dense, undeformed solids are perfectly elastic. Hence the basal problem of geophysics is to find the law of elastic compressibility. This can not be accomplished by direct means, but the task is, nevertheless, as pointed out above, not a hopeless one, and has been taken in hand. Should success be achieved, researches will follow on the variation of elasticity with temperature. This feature of the investigation will present very great experimental and theoretical difficulties, but there is no good reason to despair of success.

When the law of resistance of solid bodies becomes known as a function of both temperature and pressure, even for isotropic substances with only two moduluses of elasticity, the way will be opened to various important investigations, largely mathematical in character. It is true that thoroughly isotropic bodies are seldom met with, yet geological masses must, nevertheless, often approach closely to this ideal. Many of the most important rocks are chiefly composed of triclinic feldspars, which, indeed, occur about as abundantly as all other minerals found at the surface of the earth put together. A triclinic feldspar crystal rejoices in the full possible number of elastic moduluses, 21. Yet a large spherical mass of small, fortuitously oriented feldspars will behave to external forces of given intensity and direction in the same way, no matter how the sphere may be turned about its center, and will, therefore, act as an isotropic body. This fact is enough to show that an infinite variety of intimate molecular structures are compatible with molar isotropy.

Thus a knowledge of isotropic elasticity will suffice as a basis for testing reasonable hypotheses of the constitution of the earth's interior, taking into account its known rigidity and density. Still greater light can be thrown on this subject by including in the investigation the moon and Mars; for their masses and dimensions are

known and there seems every probability that they are composed of the same materials as the earth, though in different proportions. If a given hypothesis as to the chief constituents satisfies the known conditions of all three planets, it will doubtless find acceptance. Such a result would open the way to fresh advances in geodesy and terrestrial magnetism, and cast backward through the vista of time a ray of light on the nebular hypothesis.

Again, when the law of elasticity and the approximate constitution of the globe are known, it will be possible to work out a satisfactory theory of the simpler modes of vibration in a terrestrial sphere, and then seismological observations can be applied to determining more precisely the intrinsic elastic moduluses of the earth along the paths of earthquake waves.

It will also be practicable to examine critically the possible rupture of the globe as a consequence of change of figure and to study intelligently the simpler cases of the crumpling of strata, fissuring and other problems in the mechanics of orogeny.

The science of elasticity has had a very disappointing history. Simple as is the assumption *ut tensio, sic vis,* the attempt to solve even such seemingly elementary problems as the flexure of a uniformly loaded rectangular bar leads to insoluble equations; so that the science has been relatively unfruitful. It remains to be seen whether a truer relation between load and strain will not simplify formulas and increase the applicability of algebra to concrete cases.

From an astrophysical point of view the dialytic action of mineral septa is unimportant, but it is very interesting in its bearing on metamorphism and ore deposition, and may readily contribute to economic technology.

The relations of viscosity to the diffusion of matter have not yet been elucidated even for ordinary temperatures. This subject is one of much importance in connection with the genesis of rock species, and of course it should be studied at 10° before undertaking researches at 1000°.

High temperature work is essential even to the investigation of the elastic problem and it is almost a virgin field. Even thermometry is very imperfect above the melting point of gold, though it is destined soon to become exact at least as high as 2000°, a range which will probably suffice for geophysics. But we are also in almost total ignorance of the extent to which the laws of physics, studied at ordinary temperatures, prevail at one or two thousand degrees. One of the less difficult problems of this group is that of thermal conductivity and specific heat of solid bodies at high temperatures. For the principal metals this is already known as far as 100°, but not for rocks or minerals. It would be especially desirable to have such determinations for granite, basalt and andesite, the last representing the average composition of the accessible part of the lithosphere.

It seems to me that when the thermal diffusivities are known for these rocks, over a range of a thousand degrees, the question of upheaval and subsidence can be attacked with a good prospect of success. A cooling sphere is conceivable in which the distribution of thermal diffusivity is such that the flow of heat would be 'steady,' in Fourier's sense, and thus accompanied by no superficial deformation. With any other distribution of diffusivities, deformation would occur, and the globe would act as an imperfect heat engine, the work done being that of upheaval or subsidence. Now when the assuredly variable value of diffusivity for the materials of the globe is known, the mathematical conditions for steady flow can be worked out, and if these are not consistent with the facts of the

globe, a *vera causa* for upheaval will have been found, which may lead to further and more detailed conclusions. It should also either elucidate or simplify the subject of the fusion of magmas and their eruptive expulsion.

The data for constitution and thermal diffusivity will readily be applicable to the problem of the earth's age and will yield a corrected value of the probable lapse of time since the initiation of the *consistentior status* of the Protogæa.

The most difficult field in geophysics is the study of solutions at high temperatures. This is largely because both methods and apparatus require to be invented. When work of this kind was undertaken in the laboratory of the Geological Survey, three years since, no furnace existed in which pure anorthite could be melted and a trustworthy determination of the temperature of fusion made. For the study of aqueo-igneous fusion, which must, of course, be performed at considerable pressures, extremely elaborate preparation is necessary; indeed, all attempts hitherto made in this direction have been only very partially successful.

Were it not that the number of important rock-forming minerals is small, the study of igneous solutions for geophysical purposes would be an almost hopeless task. The feldspars, the pyroxenes, the amphiboles and the micas appear to form isomorphous series and must be studied as such. They, with quartz, make up nearly 93 per cent. of the igneous rocks, nepheline, olivine, leucite, apatite, magnetite and titanium minerals substantially completing the list which enter into these rocks in sensible proportions. After the melting points of the minerals have been determined and their isomorphism has been studied, the most important research to be undertaken is that on their eutectic mixtures. Other features, however, must receive attention, such as their latent heat, ionization, viscosity and diffusivity. Immensely interesting will be the study of melts into which hydroxyl enters as a component and which may turn out to be emulsions rather than solutions. Such researches will constitute a most substantial addition to physical science and, as pointed out above, offer a good prospect for the rational classification of rocks.

Enough has been said to show how closely geophysical researches interlock. Researches at high temperatures must accompany investigations at common temperatures, physics must be supplemented by physical chemistry, mathematical ability of the highest order must be called upon at every step to elucidate difficulties and to draw inferences capable of being again submitted to inquiry, and some geological knowledge, too, is requisite to appreciate the bearing of results and to indicate the questions of importance. No human being has the length of days, the strength, the skill or the knowledge needful to undertake, without help, the investigation of geophysics as a whole. Only a few of the topics touched upon in the earlier pages of this essay are independent of cooperation; for instance, the astronomical conditions favorable to glaciation and perhaps the application of the mathematics of capillarity to the problem of erosion. On the other hand, the list of geophysical problems requiring cooperation could be almost indefinitely extended even now, and will be supplemented when the most pressing questions approach their answers.

Organization increases efficiency in scientific work as much as in technical pursuits, though it has seldom been attempted. Instances in point are the U. S. Geological Survey, the Reichsanstalt and astronomical surveys of the sky. Geophysics, then, is

too difficult a subject to be dealt with excepting by a well organized staff, working on a definite plan resembling that indicated above. The tastes and convenience of individuals must give way to the methodical advancement of knowledge along such lines that the work of each investigator shall be of the utmost assistance to the progress of the rest.

Work in geophysics is already in progress in this country, thanks to the appreciative sympathy of Director Walcott, of the Geological Survey and the liberality of the Carnegie Institution, by members of my staff and in part under my direction. Messrs. A. L. Day and E. T. Allen have made an excellent series of determinations of the melting points of the triclinic feldspars and studied their other thermal properties. They are now preparing to make experiments in aqueo-igneous fusion. Mr. C. E. Van Orstrand has made a novel application of the theory of functions to elastic problems and has reduced several series of important observations on elastic strains for comparison with theory. Dr. J. R. Benton is occupied in experimental investigation of elastic strains in various substances. The men engaged in these researches are able and devoted to their work, but they are too few in number, and they are required to make determinations of the most delicate character in an office building standing in the busiest portion of Washington, where the walls are in a state of incessant tremor and where there is no suggestion of uniformity of temperature. Under such circumstances the results of observation can not be of the most refined character and must be obtained at great expense of time and effort.

Most of the great physicists of the world have expressed their interest in geophysics and their belief that the time is ripe for its investigation. Geologists are eager for its results, but no government can undertake investigations so remote from industry as this. I do not think I can more fitly conclude this paper than by quoting a resolution introduced by Mr. S. F. Emmons at Vienna a year ago. It was passed by acclamation by the Geological Congress, after a ringing speech by Professor Suess, and it expresses my own views most accurately.

EMMONS'S RESOLUTION.

"It is a well-known fact that many of the fundamental problems of geology, for example those concerning uplift and subsidence, mountain-making, vulcanology, the deformation and metamorphism of rocks and the genesis of ore deposits, can not be discussed satisfactorily because of the insufficiency of chemical and physical investigations directed to their solution. Thus, the theory of large strains, either in wholly elastic or in plastic bodies, has never been elucidated; while both chemistry and physics at temperatures above a red heat are almost virgin fields.

"Not only geology but pure physics, chemistry and astronomy would greatly benefit by successful researches in these directions. Such researches, however, are of extreme difficulty. They would require great and long sustained expenditure as well as the organized cooperation of a corps of investigators. No existing university seems to be in a position to prosecute such researches on an adequate scale.

"It is, therefore, in the judgment of the Council of the Congrès Géologique International, a matter of the utmost importance to the entire scientific world that some institution should found a well-equipped geophysical laboratory for the study of problems of geology involving further researches in chemistry and physics."

George F. Becker.

THE DOMAIN OF PHYSIOLOGY AND ITS RELATIONS TO MEDICINE.*

PHYSIOLOGY is of medical parentage, was reared by medical men and is still housed and fed by medical faculties. Still it is medicine against which its frequent declaration of independence is directed. Medicine is a practical science and is too inexact, and physiology wishes to be a pure, exact science. It, therefore, tries to keep aloof from medicine and manifests a longing for association with or, still better, for a reduction to, physics and chemistry. It urges, furthermore, that the affiliation with medicine binds physiology down to only one species of animal with intricate, complicated conditions, while it would be more beneficial to physiology if it would direct its energies towards a study of monocellular organisms where the conditions are so simple.

Permit me to discuss briefly the domain of physiology and the importance of its relations to medicine as they present themselves to my mind. There can be no doubt whatsoever that physiology has a perfectly legitimate object entirely of its own. Perhaps I may elucidate this statement in the following crude way. All natural phenomena impress us in two ways—as matter and as force. The phenomena are either inanimate or animate. The studies of inanimate matter are to be found in mineralogy, crystallography, in a part of chemistry, etc. The studies of the forces or energies of inanimate phenomena are carried on by physics and physical chemistry. In the fields of living phenomena, matter is studied by gross and minute anatomy and by descriptive zoology and botany, or in short by morphology. The studies of the forces, the energies or the functions of living matter, are the proper domain of physiology. Now this definition permits a few deductions. All these four divisions are bound, as sciences, to have something in common in their methods of investigation; they must employ the inductive method and must strive to reach in their results that degree of certainty which the nature of each individual science permits it to attain. But the four divisions differ greatly from one another; each one has its own subjects and laws and its own problems, which have to be solved by methods peculiarly adapted for each division. It is certainly clear to every one that it can not be the essential task of animal morphology to reduce itself to mineralogy because it can be demonstrated that some anatomical objects contain lime and other mineral substances. It seems to me it ought to be also clear to every one that it can not be the sole task, and not even the essential task, of physiology to reduce itself to physics and chemistry because some or many of the living phenomena are governed to some extent by known laws of physics and chemistry. Physiology has to study the functional side of life, and in the attempts to elucidate its complex phenomena it certainly has to employ also the known facts of physics and chemistry. But if we would confine the domain of physiology to such parts only which can be interpreted by the laws of physics and chemistry of to-day, we would have to give up nine hundred and ninety-nine out of a thousand of the phenomena of life as still inappropriate for physiological study. The four divisions of the natural sciences are closely interwoven and each one can, of course, profit by the experience of the others. Boyle, Mayow, Priestley, Lavoisier and others attempted to unravel the nature of oxygen, nitrogen and carbon dioxide gas by the aid of experimental studies of the physiology of respiration. The physicist or the chemist employs any method which would help him

* Chairman's address at the Section of Physiology of the World's Congress of Arts and Science, at St. Louis, September 23, 1904.

to shed light upon his subject, but physics and chemistry have methods peculiar to themselves and that is the secret of their great success. And so it should be with physiology. However, when physiology broke away from medicine, it ran into the arms of physics and chemistry and is still largely there. The early successes which have attended the new venture, which, by the way, is the case with every new venture, led to the conception that this is the most desirable, the most natural union. An analysis, however, of the work in animal physiology in the last few decades will show the fact that the too great gravitation towards physics and chemistry prevented the development in many directions of a purely physiological character.

I contend that physiology is an independent science with a clear outline of its domain, but it ought to direct its declaration of independence not only towards medicine, but also towards such exact sciences as physics and chemistry.

As to the standard of precision and exactness to be required of physiology, let me say this. Certainly no physiological problem can be solved with that exactness, with that absolute reliability which is now the standard for a good many problems in physics and chemistry. Above all in the studies of the energies of life we lack the controlling factor of synthesis. If we can produce synthetically urea or sugars or other dead constituents of a dead or living body, we can not yet make synthetically the smallest living organ of the smallest homunculus. But what of it? Each science has its own degree of attainable exactness. Physics and chemistry have one standard and paleontology or geology is bound to have another standard of exactness. There is no one standard of exactness for all sciences. The scientific demand upon work in any science is to strive for that degree of exactness which is attainable in each specific field of investigation.

I contend, further, that physiology ought not and can not be properly developed upon the basis of a morphological unit. We might just as well attempt to put up the mineral crystals as a basis for the study of physics.

I may say, further, that in my opinion the knowledge of vital energies would progress more rapidly if we would be guided in our investigations by the view that the actual processes in the phenomena of life are of a very complex nature. The desire to reduce the multiplicity of phenomena to a few simple principles is a philosophical importation of a psychological origin. Certainly premature attempts to offer simple interpretations for complex phenomena have often been an obstacle for a further development of our knowledge of the actual processes.

Physiology, however, may take some useful hints from the other sciences. It may learn from such exact sciences as physics and chemistry that the exactness and dignity of a science do not suffer by coming into intimate contact with the necessities of daily life. On the contrary, we find that those chapters of physics and chemistry whose results found practical application, are best developed. The contact of a science with life and its actual necessities works, on the one hand, as a stimulus to investigation, and, on the other hand, as a corrective against an indulgence in mere hobbies. The experimental method as such is no talisman against such scholastic degeneration. A study of the literature of the last few decades will show that physiology, too, could well stand such a corrective.

Physiology could also learn from morphology that a special attention to the human being does not necessarily lead to a neglect of the uniform study of the entire

animal kingdom. The marvelous complete studies of gross and minute human anatomy, which was of such immense service to pathology and surgery, was in no way an obstacle to the brilliant development of the broad science of zoology.

There is, however, one difference between the studies of the energies of inanimate phenomena and the studies of the vital energies to which I would like to call special attention. For physics there is only one kind of energies; they are all normal. If the physicist meets with conditions which apparently do not agree with some established law, he does not transfer these conditions to a pathologist in physics for further investigation. On the contrary, he is only too glad to have such an opportunity; it usually leads to an elucidation of the old law, or still better, an entirely new law might be discovered. When Kirchhoff was surprised by the apparently contradictory fact that by the addition of the yellow light of sodium to the sunlight the dark *D*-lines in the spectrum instead of becoming lighter became still darker, he did not turn away from the problem. On the contrary, he was glad of this opportunity; in fact, as he stated once, he was longing to meet such a complete contradiction. The result was the establishment of the law of the proportion between emission and absorption of light and the creation of the nearly new science of spectral analysis. Or to quote a more recent instance, the exceptions to van't Hoff's law of osmosis which were met with in salt solutions and which had been displayed by some as a proof against the validity of that law, served Arrhenius as a basis for the establishment of the far-reaching law of electrolytic dissociation. It is totally different, however, with physiology. Its domain is, as we saw above, the study of the functional side of living phenomena. Here, however, we find the artificial and unsound distinction between normal and abnormal functional phenomena. Physiology set up some laws; and if conditions appear which do not fit in with these laws, physiology declines to deal with them, it refers you to medicine. Are the laws governing the vital functions under pathological conditions actually different from those controlling the functions in health? Certainly not. The laws which physiology establishes must be capable of covering the functional phenomena in all conditions of life. The apparent exceptions in disease should serve in physiology, as in physics, to unravel the real nature of the laws governing the functions of living phenomena, whether they occur in health or in sickness. For instance, the processes occurring while the body is in a state of fever should give a clue to the understanding of the mechanism of the constancy of the elevated temperature of warm-blooded animals. Or the conditions prevailing when urine contains albumin should be seized as a means of studying the remarkable phenomenon in the normal urinary secretion, namely, that of all the endothelial cells of the body the kidney endothelia alone do not permit normally the passage of albumin. Or the conditions of the blood and the lung tissues in pneumonia could serve as an aid in studying the factors concerned in the formation of fibrin. And so on and so on in many thousand instances of daily occurrence. Some very important discoveries in physiology were thus recently brought to light through medical experience and by medical men, with hardly any aid from physiology. The anatomy of the cases of myxœdema and cretinism and the results of the complete removal of the thyroid gland for goitre revealed the physiological importance of that ductless gland for which physiologists, with one single exception, had no interest. This discovery helped at the same time to establish and to introduce

into physiology the far-reaching conception of internal secretion. Furthermore, the observation of Bouchard, Lancereaux and other medical men of the occurrence of a degeneration of the pancreas in cases of diabetes mellitus, led to the discovery, by two medical men, of the remarkable fact that the complete removal of the pancreas in dogs leads to diabetes. This discovery demonstrated at the same time the further principle that even glands with a distinct external secretion have besides a physiological importance for the body by virtue of their internal secretion. In the long list of workers on this subject we hardly find a single physiologist.

I could quote a good many more instances in which medical studies brought out important physiological facts and how physiology is slow to avail itself of such golden opportunities.

The physicists are only too glad to meet with exceptions; the physiologists run away from them. Is there any well-founded justification for such a course in physiology? I believe none. I believe it is simply an erroneous position. It would lead me too far to attempt here a discussion of the causes which led to this position in physiology. But I say without hesitation that this position is deplorable, is harmful to physiology as well as to medicine. Animal experimentation is the essential method of developing physiology. Now then nature makes daily thousands of experiments upon man and beast and physiology refuses to utilize them for its own elucidation. I feel quite sure that a study of the functional processes in pathology, or at least the systematical taking up of physiological problems indicated by pathological processes, by minds naturally endowed and properly trained for physiological studies, would greatly elucidate the proper sphere of physiology itself and would at the same time be of incalculable value to pathology and medicine.

And medicine is greatly in need of such a physiology. I am afraid that the actual situation in medicine is not fully grasped even by a great many of its enlightened disciples. To state the critical point in a few words: The actual disturbance in most of the diseases is primarily of a functional nature, but the essential part of the present knowledge in medicine is morphological in its character! This discrepancy is due to the uneven development of the sciences of medicine. When the empirical art of medicine awoke to the necessity of acquiring a scientific basis, it found ready for its disposal an already well-defined precise anatomy, but only a vague, incoherent physiology. It set out and continued to work in the precise lines of anatomy, in which it attained a marvelous completeness. By this step, however, morphology became the dominant factor in medicine and the definition of a disease became inseparably coupled with that which was found in the body after it succumbed to the disease. When at a later period physiology also became a precise science, it broke away at the very onset of its regeneration from medicine; it wished to be exact, to be a pure science, and thus gained no influence upon pathology, which it refused to study. So it came about that medicine is made up of a complete knowledge of the anatomical conditions after death, of nearly a complete morphology of the symptoms of the disease during life, but of only a vague, makeshift mechanical interpretation of the functional disturbances during the actual course of the disease. The last decades have seen the birth and marvelous growth of the knowledge of the ætiology of disease. Animal and vegetable invaders were recognized as the essential cause of many diseases. But the study of the functions of the body whose lot it is to grapple with the invaders

received only a secondary attention, and that again essentially from morphological quarters. At the present time still more knowledge is being diligently added to the stores of medical wisdom. Chemistry has taken a powerful hand in the studies of physiology and pathology and is attaining brilliant results. But we should not be misled. The studies are essentially morphological in their nature. It is physiological and pathological chemistry, and but very little chemical physiology and pathology. Even if the hopes of the new school of brilliant chemical investigators will, indeed, be realized, viz., that in a not far off future they will know the structure of proteids and all their constituent bodies, it will be the knowledge of the proteids of the dead bodies, it will be a brilliant post-mortem chemistry. Living animal matter, however, is something else than dead proteids, as living plants are something else than carbohydrates, although the knowledge of the latter has already reached the ideal stage where some of them can be produced synthetically. No, a study of life, normal and abnormal, is essentially a study of energy, of function; of course, the knowledge of the underlying morphology, dead or living, is a prerequisite for such studies. And let me state right here that there seems to be a difference in the make-up of the human mind with regard to the different studies. Some are more apt and better endowed to grapple with the problems of energy, and others again have natural talents for the science of morphology. Only few, however, have the good fortune of becoming educated in the lines of their natural endowments, and still fewer have the genius to work out their natural destinies against all odds, against all education and training. Now the men who did and who now do the original work in the medical sciences received their training in the studies of medicine, four fifths of which is profoundly developed, magnificent morphology. We can not wonder, therefore, that most of the original contributions to the medical sciences are essentially of a morphological character. Even in the very recent brilliant additional departments of medicine, in bacteriology and chemistry, the research work is, as already stated above, for the most part of a morphological stamp. It is true that a few men of genius in medicine, Cohnheim for instance, broke their acquired chains and made an attempt to study pathology from a functional point of view. Such attempts, however, were not many and their permanent influence is not extensive. What is now termed general pathology or even pathological physiology consists, in the first place, of a collection of histological, bacteriological and chemical facts of a general but essentially of a morphological nature, including at the same time the applications of a few well-established physiological facts to pathology and a few results from direct experimentation in pathology. That is not a study of physiology under pathological conditions, and certainly not a study of general physiological laws which can be stimulated by and derived from a study of pathological processes. And it is just this kind of study which is missing, and which could be developed only by a purposeful and concerted action of the men who have a training in the study of the functional side of life, among whom there are surely many who have a natural endowment for such studies.

The following review of the present situation in medicine will show us the place left vacant by physiology and the disastrous consequences. The studies of pathological anatomy extend over all divisions of medicine, are lucid and nearly complete. Diseases which are exclusively due to palpable anatomical changes are quite well understood. Their harmful effects are, for

the most part, of a mechanical nature. In proportion as they are understood, these forms of disease become amenable to an efficient treatment; it is mechanical, it is surgery.

The studies of the ætiology of diseases revealed and continue to reveal many of the foreign originators of disease, the animal and vegetable invaders of the living organism. This new and lucid knowledge led again to some effective measures in the treatment of diseases, it led to clear plans in preventive medicine, it gave means to the surgeon to enter with impunity into the interior of living organisms, and in a few instances it discovered actual remedies for non-surgical diseases.

But most diseases are something more than mechanical disturbances, or exclusively anatomical changes. There is, in the first place, that large group of so-called functional diseases which has no pathological anatomy, and for which clinicians have very little interest. But even those numerous diseases in which the post-mortem examination revealed distinct anatomical changes were only results of the advanced stage of the disease. The disease during life consisted primarily surely in disturbances of a functional character, in reactions to foreign causes, reactions of living energies, the physiology of which we have possibly as yet not even an inkling of. The so-called organ physiology which appears to the teachers of physiology to be so extensive that it can hardly be taught to students of medicine in one year's lectures, is of astonishingly modest assistance to the understanding of the actual processes of disease. For instance, in the present knowledge of the entire section of the diseases of the respiratory tract, physiology has hardly any share. The knowledge of the few physiological principles which are applied there can be acquired in one hour's instruction. The extensive knowledge in this chapter of pathology is essentially of a morphological nature. Do the functions of the involved organs take no part in these pathological processes? Most certainly they do; but we know too little of it, and the clinician passes over the gap with some makeshift mechanical explanations. The same is true in neurology; in fact, in nearly every chapter of internal medicine. It is impossible to dwell here on the particulars of our subject. What is the result? First-class clinicians employ their brilliant faculties in continually developing the morphology of diseases and their diagnosis. But treatment? There is either a nihilism pure and simple, or some sort of a symptomatic treatment is carried on with old or new drugs upon a purely empirical basis. Or there is a great deal of loose writing upon diet, air, water, psychotherapy and the like, and a great deal of semi-popular discussion in international, national and local meetings and popular prize essays on the best methods of treatment—with a net result of only a very modest actual benefit for the poor patient, who in addition to his affliction has now to feel the tight grip of the modern health officer. There is no efficient treatment of internal diseases in any way comparable with the specific surgical treatment of mechanical diseases, no specific quelling, correcting or curbing of primarily functional disorders. And there never will be such a specific functional therapy before there will be a physiology which, like physics, will be only too glad to meet with many exceptions in order to properly understand all the rules by which the energies of all grades of living phenomena are guided.

S. J. Meltzer.
Rockefeller Institute.

SCIENTIFIC BOOKS.

Blood Immunity and Blood Relationship. By George H. F. Nuttall, M.A., M.D., Ph.D., University Lecturer in Bacteriology and Preventive Medicine, Cambridge. In-

cluding original researches by G. S. GRAHAM-SMITH, M.A., M.D., D.P.H., Camb., and T. S. P. STRANGEWAYS, M.A., M.R.C.S. Cambridge University Press. 1904.

The recent study of the mechanism of immunity begun by Bordet and Ehrlich has opened an entirely new chapter in biological science and has already yielded some practical results of great interest and importance. None of these practical aspects of the new science has been so prolific of immediate results as the study of the precipitins. These specific proteids are developed in the animal body by injection of foreign proteids, as blood-serum, milk, bacterial emulsions, etc., and their presence in the blood of the treated animal is indicated by the fact that when the blood-serum is added *in vitro* to the alien blood or to the bacterial emulsion used in the injections, a precipitate occurs from the union of the newly-developed precipitin and the foreign proteid. The precipitins are highly specific, acting only on the proteid injected, so that when a rabbit has received several injections of human blood, its serum precipitates the proteids of human blood, but not those of beef, sheep or any other lower animal blood. The first application of this principle has developed the medico-legal serum test for blood which has become fully established as a reliable test in forensic cases.

Nuttall and his associates were among the first to see the possibility of establishing by means of the precipitin test a far more accurate scheme of relationships in the animal kingdom than has been possible by any other method, and the results of their studies, extending over a period of three years, are presented in detail in the present volume.

The elaborate scope of the work may be judged by the fact that Nuttall himself prepared in the rabbit anti-sera for the bloods of thirty different animals and records no less than sixteen thousand tests on the blood of nine hundred animals. Only the barest outline of the many important results of this extensive work can here be indicated.

In general, Nuttall succeeded in establishing a close blood relationship in different classes of animals which zoologists have grouped together chiefly on anatomical grounds. Among the most interesting of these relationships is that between the Anthropoidea. It is a somewhat startling verification of the consanguinity of man and the higher monkeys that the blood of the chimpanzee gives 90% as much precipitum with humanized rabbit serum as does the blood of man himself, while the blood of lower monkeys yields only one fourth or one third as much. The chimpanzee thus appears much more nearly related to man than to the common Rhœsus monkey. Another interesting result is the observation that anti-pig serum is remarkably diffuse in its action, affecting considerably the blood of primates and showing that the porpoise has correctly been called the 'sea hog.'

Numerous conflicting results are recorded, which is not a matter of surprise, considering that the specimens of blood were collected on blotting paper, often under great difficulties, and sent by mail from nearly all parts of the world. As the author states, only a beginning of the study of blood relationships has been accomplished and much remains to be done in determining the exact standing of different animals in their respective classes. It is of fundamental importance to have established the fact that the precipitin test is universally applicable as a method of zoological rating, and may have much influence in elucidating many problems of evolution. It may be suggested that new points of view may, perhaps, be secured and former results be effectively controlled by comparing the action of anti-sera for the same blood prepared in other animals as well as in the rabbit, which is the animal almost exclusively employed by workers in this field.

The method of estimating the degree of reaction by measuring the bulk of precipitate is one of the many important contributions of the author to the technics of serum work.

Graham-Smith contributes an extensive study of anti-sera among lower vertebrates and arthropods, and an important critical study of the medico-legal application of the test. This investigator more than any other has demonstrated the possible sources of error in the medico-legal use of the test, so that

familiarity with his work is essential for any one who undertakes the employment of the serum test for human blood.

Not the least valuable and laborious feature of the volume is the very complete critical summary of the literature of the precipitins, for the preparation of which the thanks of all students of the subject are due. J. EWING.

Praktikum für morphologische und systematische Botanik, Hilfsbuch bei praktischen Uebungen und Anleitung zu selbständigen Studien in der Morphologie und Systematik der Pflanzenwelt. By KARL SCHUMANN, late curator of the Royal Botanical Museum at Berlin. Jena, G. Fischer. 1904.

Professor Karl Schumann's posthumous text-book of morphological and systematic botany is a stout imperial octavo of six hundred pages. The work was largely in type at the time of Professor Schumann's death, and in accordance with his wish it has been brought to completion under the editorial supervision of his able colleague, Professor Max Gürke. The plan of the volume is to illustrate the facts of the morphology and classification of the flowering plants by describing in considerable detail seventy-nine species, selected to typify the most important families and arranged in the general sequence of their flowering seasons. The work is the result of wide experience and intensive study in the fields covered. By its wealth of carefully recorded facts, its conscientious detail and perfect lucidity it must at once command respect. As a laboratory guide, however, it will scarcely prove successful, at least in America. Of the plants treated, the majority are European species not generally familiar, even in cultivation, on this side of the Atlantic. It is true, the descriptions would in many instances apply with a fair degree of accuracy to nearly related American species of the same genera, yet the correspondence would be imperfect and perhaps misleading. Furthermore, students of one nationality doubtless differ somewhat in their psychological traits from those of another. It may well be, therefore, that a type of text-book suited to one nation may not be equally adapted to another. In fact, it is the general experience in America that a laboratory guide in order to be effective in holding the attention of the student and stimulating his interest should present its subject not by long and full descriptions, but rather by indicating methods of observation and leading the student to examine and discover for himself.

One of the chief defects of the book under discussion is that, dealing as it does with an arbitrary number of unrelated species, it would leave the student with but a vague idea of the relative systematic importance of the morphological features examined, since in general he would be unable to distinguish the traits characteristic of and restricted to the particular species from the more general features common to other plants of the same genera and families. There is, in fact, little effort to correlate and draw together by any form of systematizing or generalization the morphological characteristics, which are described separately for each of the seventy-nine species.

The introductory matter is very brief, dealing chiefly with the simple microscope and the ordinary methods of plant dissection. The closing pages are, however, devoted to some excellent hints to students entering upon monographic and floristic work. There is also a list of the chief floras of different lands. This seems to have been prepared with some haste, since it contains a number of clerical or typographical errors. Surely a work which urges (p. 578) the careful verification of all citations should not set the poor example of mangling names of well-known authors, as, for instance, 'J. W. Hooker' (p. 599), 'Nathaniel Britten' (p. 600), or 'N. B. Hemsley' (p. 602). It is fair to say, however, that many such trifling slips should be pardoned in a large and posthumous work.

The volume is copiously illustrated from drawings on granulated paper executed by the author's daughter. The figures are exceedingly clear and bear ample evidence of fidelity to nature. It is a pleasure to notice that they are all fresh and original, none having been borrowed from any other work.

B. L. R.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette, for October, contains the following articles: Bradley M. Davis has discussed the relationships of sexual organs in plants, presenting their classification based upon certain evolutionary principles and also suggesting a terminology that is more precise.—Bruce Fink has contributed another paper upon the 'ecology' of a lichen society, this time considering a curiously isolated society upon a sandstone riprap in Iowa.—J. Y. Bergen has given some results of his observations in Italy on the transpiration of sun leaves and shade leaves of the olive and other broad-leaved forms, showing in general that xerophytic leaf structure is not always incompatible with abundant transpiration.—A. S. Hitchcock, in his fourth paper, entitled 'Notes on North American Grasses,' discusses *Poa serotina* Ehrh. and *P. flava* L., and also the genus *Digitaria Heist.*—F. L. Stevens has made a further contribution to our knowledge of oogenesis and fertilization in the genus *Albugo* by presenting his results with *A. Ipomoeae-Panduranae*.

THE September issue of the journal of *Terrestrial Magnetism and Atmospheric Electricity* has as its frontispiece the portrait of Alexander von Humboldt, and contains besides notes and abstracts and titles of recent publications, the following articles:

N. UMOW: 'Die Construction des Geometrischen Bildes des Gauss'schen Potentials, als Methode zur Erforschung der Gesetze des Erdmagnetismus.'

L. A. BAUER: 'The Physical Decomposition of the Earth's Permanent Magnetic Field, No. IV.' a. Introductory Note; b. Secular Motion of a Free Magnetic Needle; c. Vertical Earth-Air Electric Currents; d. Residual Magnetic Field and Diurnal Variation Field.

L. A. BAUER: 'Appeal for Cooperation in Magnetic and Allied Observations during the Total Solar Eclipse of August 29–30, 1905.'

W. VAN BEMMELEN: 'Magnetic Survey of the Dutch East Indies.' (Second Communication.)

J. DE MOIDREY: 'Note sur l'Amplitude de l'Oscillation diurne de la Déclinaison Magnétique et son Inégalité Annuelle.'

G. W. LITTLEHALES: 'Magnetic Declinations by Peary in the Arctic Regions, 1900-02.'

W. F. WALLIS: 'Principal Magnetic Disturbances recorded at Cheltenham Magnetic Observatory, May 1–August 31, 1904.'

DISCUSSION AND CORRESPONDENCE.

THE STOMACH STONES OF THE PLESIOSAURS.

APROPOS of Dr. Eastman's letter on the 'stomach stones' of the plesiosaurs, published in SCIENCE, No. 510, p. 465, permit me to state that there is not a shadow of doubt that the plesiosaurs, both Cretaceous and Jurassic, had the habit of swallowing such stones. At least thirty instances are now known of the occurrence of the very peculiarly worn pebbles between the ribs or with the remains of plesiosaurs in both Europe and America. The fact was first published by Professor Seeley, of England, in 1877, and Seeley it was who first suggested their use in digestion and the possession of a 'gizzard' by these animals. This absolves Mr. Brown. Crocodiles are frequently reported to have like habits, and Buckland says that the Arabs determine the age of these animals by the number of the stones found in the stomach, one being swallowed each year! Similar pebbles have also been found with the remains of extinct crocodiles, and St. Hilaire gives a minute account of such instances. I need not say also that there are various accounts in the literature of like habits possessed by some of the seals and sea-lions. I doubt not that the habit was an intentional one with the plesiosaurs, nor do I think that Dr. Eastman would doubt either, had he ever collected the remains of these animals in the field. That the plesiosaurs had a gizzard-like stomach I do not believe, but I see nothing startling in the suggestion—with due apologies to Dr. Eastman. His argument, that, if the plesiosaurs were of lithophagous proclivities, other reptiles should be expected to gorge themselves on a like mineralogical diet is hardly pertinent. The prairie chicken has the regulation gallinaceous gizzard, and, therefore, the sage hen should have one. But it has not. *Ab uno disce omnes* is not always safe. And, it must be remembered, all reptiles have stomachs with thick muscular walls.

S. W. WILLISTON.

SPECIAL ARTICLES.

AN ARTIFICIAL ROOT FOR INDUCING CAPILLARY MOVEMENT OF SOIL MOISTURE.

THE rate at which a plant is able to secure water from a soil, under any given conditions, depends upon two factors: (1) The pulling force which a plant is able to exert upon the water in the soil, and (2) the capillary force with which the soil holds the water which it contains. Under a condition of equilibrium, this latter force could be expressed in terms of the curvature of the capillary surfaces. When the water in the soil begins to move, however, there is introduced, in addition to the static pull of the curved capillary surfaces, a resistance to the movement or translocation of the water over the surface of the soil particles. This resistance, which obviously depends upon the thickness of the film, must be taken into consideration in all questions relating to the rate of movement of the capillary moisture in soils.

In order to determine the rate at which a given soil with a given moisture content is able to supply moisture to the roots of a plant, one must create in the soil at some point a pulling force analogous to the action of the plant root. This may be done in several different ways:

1. The surface of the soil may be exposed to evaporation, thus producing an upward movement of the water from the lower portions of the soil. This method is open to serious objections. The surface soil soon becomes air-dry, unless the water content is kept abnormally high, so that evaporation must take place more or less from within the soil mass, which leads to indeterminate conditions. Furthermore, previous experiments have shown that the distance through which water will rise in a dry sand is only one fourth the distance through which a vertical movement will take place in moist sand.* From these facts it is evident that the capillary movement induced by a dry surface soil is not representative of the capillary movement in the soil surrounding the active roots of a plant, where the soil grains are covered with water films.

2. An osmotic cell buried in the soil may be used to produce an inward movement of the soil moisture towards the cell,* provided the osmotic pressure of the cell solution is greater than the capillary pressure of the soil moisture.† Unfortunately, the rate at which water diffuses into a cell of this kind is so slow as to preclude the possibility of taxing the soil by this method, except under conditions approximating drouth. This, combined with the changes in concentration which take place at the inner wall of the cell as water enters, and the difficulty experienced in preparing cells capable of withstanding high pressures, makes the method in general unsuitable for investigating the rate of capillary movement. When the moisture content of a soil is reduced to such an extent that the rate of movement is extremely slow, the osmotic cell furnishes a very beautiful means of producing in the soil a capillary pull of known magnitude.

3. The method which we are about to describe avoids the errors and difficulties incident to the two methods outlined above. The apparatus consists of a close-grained unglazed porcelain tube, closed at one end, and provided at the other with a tubulure, by which it can

* Briggs and Lapham, Bull. 19, Division of Soils, U. S. Dept. of Agri., 1900.

* Cameron (Bull. 22, Bureau of Soils, Dept. of Agri., 1903) has shown experimentally that when an osmotic cell, having a calculated osmotic pressure of 36 atmospheres, is buried in a soil, there is an inward or outward movement of water depending upon the moisture content of the soil.

† The capillary pressure of the soil moisture is due to the existence of curved water-air surfaces within the soil which tend to contract and thus produce a pressure outward along the normal to the water-air surface. This surface can actually move outward only by drawing in additional water from surrounding capillary spaces. If the moisture in the soil is in equilibrium the curvature of all the water surfaces at a uniform level is the same. The pressure exerted by the capillary surfaces depends upon the curvature and the surface tension. When the moisture content of the soil is diminished, the curvature, and consequently the capillary pressure, is increased. See Bulletin 10, Div. of Soils, U. S. Dept. Agri., 1898.

be connected to an exhausted receiver. When a tube of this kind is moistened, so that the pores are filled with water, and the tube is protected from evaporation, it can be exhausted to a pressure equal to the vapor pressure of water, and, if connected to a two-liter receiver, it will maintain that difference in pressure for a day or more without sensible loss. It is evident that under these circumstances the curvature of the capillary water surfaces on the outside of the tube must exceed the curvature of the capillary surface on the inside of the tube by an amount sufficient to produce a pressure of nearly one atmosphere.

Suppose now that a tube of this kind be buried in a moist soil having a moisture content sufficiently high to reduce the pressure of the capillary water surface in the soil to less than one atmosphere. Under these conditions, a movement of moisture must take place from the capillary spaces of the soil to the capillary spaces in the porcelain tube where a greater capillary pressure exists. Now the curvature of the capillary water surface on the outside of the porcelain tube must always be sufficient to withstand the pressure of one atmosphere produced by the exhaustion of the tube, hence the water drawn into these spaces must be forced through the tube by the difference in pressure between the outside and inside of the tube, in order that the necessary curvature of the outer capillary surface may be maintained. A steady movement of water into the tube will, therefore, take place. This rate obviously depends: (1) Upon the difference in curvature of the capillary surfaces on the outside of the tube and in the soil mass, *i. e.*, upon the moisture gradient; (2) upon the resistance encountered by the water in moving over the surfaces of the grains and through the capillary spaces.

The apparatus, with which the results given below were obtained, consists of a Pasteur-Chamberland filter tube, connected by means of a short piece of lead tubing to an exhausted two-liter bottle. Air-tight connections are readily made by the use of short lengths of red rubber tubing, well coated with thick cotton-seed oil. Preparatory to placing the filter tube in the soil, a core of soil is removed by means of a tube, the external diameter of which is equal to that of the smaller end of the porcelain tube. The filter tube is slightly conical in form, so that when it is forced into this hole, a good capillary connection is established between the walls of the tube and the soil.

The apparatus was usually allowed to stand for about twenty-four hours, when the exhausted bottle was detached, and the water which had been drawn into the apparatus removed and measured. The porcelain tube was not disturbed in removing the water, which was drawn into a small flask by suction through a fine tube extending to the bottom of the porcelain tube. The apparatus was then immediately put together again and exhausted by means of an aspirator.

The water thus removed not only represents the amount of water which the soil has supplied to the tube during the preceding period of twenty-four hours, but it appears to be identical in concentration* and composition with the soil solution from which the plant obtains its food.† Therefore, the determination of the amount and composition of its soluble material gives us at once the concentration and composition of the soil solution. The apparatus thus provides a simple means of studying the changes which take place in the solution from which plants obtain their mineral food.

In the following table, the second column gives the rate in grams per hour at which moisture was supplied by the soil to the filter tube; the third, the electrical conductivity at 20° C. of the solution thus obtained, measured always in the same cell. These meas-

* No measurable change is produced in the concentration of a soil solution by filtering it through a porcelain filter-tube which is free from organic matter, and which has been thoroughly washed. A tube clogged with chlorophyll, on the other hand, does actually appear to filter out a part of the solvent from some solutions, the unfiltered portion immediately about the filter-tube being more concentrated than the original solution. See Bull. No. 19, Bureau of Soils, U. S. Dept. of Agri., 1901.

† The arguments in support of this statement will be given in a subsequent paper.

urements consequently serve to indicate the variation in the concentration of the soil solution. The fourth column gives the moisture content of the surrounding soil taken at a distance of from twelve to fifteen inches from the tube. These determinations are rather unsatisfactory, since it was not possible to obtain the samples at a uniform distance from the tube, and the moisture determinations are, therefore, not strictly comparable.

Soil Moisture Removed by Artificial Root.

Date.	Rate in Grams per Hour.	Electrical Conductivity at 20° C.	Moisture Content Per Cent.	Remarks.
June 7–8	8.9			Heavy rain.
8–9	6.5		19.2	
9–10	6.1	75.8		Heavy rain.
10–11	7.2	76.8		
11–13	5.3	78.8	18.5	
13–14	3.9	80 0	18.7	
14–15	2.8	81.6	18.1	
15–16	2.7	82.4	17.3	
16–17	2.2	84.3	18.4	
17–18	2.2	89.2	19.1	
18–20	1.8	86.5	18.1	
20–21	1.7	86.5	17.3,	
21–22	2.0	89.7	20.5	Rain.
22–23	1.6	89.8	18.3	
23–24	1.1	87.9	17.5	
24–25	0.9	88.8	16.9	
June 30–July 1	13.7	89.0	22.4	Heavy rains.
1– 2	9.5	83.0	21.9	
2– 5	4.0	86.4	17.8	
5– 6	2.2	87.9	17.7	
6– 7	1.5	88.8	17.9	
7– 8	8.3	82.0	23.2	Heavy rains.
8– 9	9.3	80.8	22 3	
9–11	12.4	84.0	22.2	Showers.
11–12	5.8	86.9	21.9	Showers.
12–13	8.1		21.7	
13–14	6.2	86.4	20.2	
14–15	4.2	88.4	18.7	
15–16	3.2	90.4	17.8	
16–18	3.5	91.2	19.3	Rain.
18–19	2.7	91.1	18.6	
19–20	2.0	92 5	17.9	

The soil in which these experiments were made had been heavily fertilized the previous year. It will be noted that the conductivity, which we may assume as approximately proportional to the salt content, steadily increased from the beginning of the observations, June 7 until June 18. The rain on June 21 apparently did not change the concentration of the solution. After the rain on July 1, the conductivity dropped from 89 to 83, after which it steadily increased until the next rain on July 7. From that time, the conductivity increased from 81 to 91 on July 16. The rain on the latter date did not change the conductivity, due, perhaps, to an accumulation of soluble material at the surface as the result of evaporation on the preceding days, which was carried down by the rain. The maximum increase in the electrical conductivity of the soil solution, taking the initial value as a basis of comparison, amounted to about 21 per cent. The increase in the total solids, determined gravimetrically by evaporating a given volume of the soil solution to dryness, was about 32 per cent., the total solids varying from 1.6 gms. to 2.1 gms. per liter of solution. The maxima in the curves, representing the variation in the electrical conductivity and total solids in the soil solution, do not always correspond, which indicates a change in the composition of the solution as well as in the concentration.

The rate of translocation of the soil moisture into the tube, at the beginning of the experiment, after a heavy rain, was 8.9 grams per hour. It fell steadily during the next two weeks to about 1 gram per hour. Heavy rains in July 1 brought the rate up to an average of 13.7 grams per hour for the twenty-four hour period, after which it fell to 1.5 grams per hour on July 7, and so on.

The rates given represent, of course, the average rate for the period. At the time of a shower, the rate would temporarily be much greater. The apparatus is amply able to remove the water as fast as it can be supplied. A tube in good condition, when immersed in water and exhausted, will take up water at the rate of 50 grams per minute, while the greatest rate recorded in the table is only about one two-hundred-and-fiftieth as fast.

The apparatus thus provides:

(1) A means of determining the rate at which water can be supplied by a soil to an artificial root, by means of which a capillary pull is exerted upon the soil moisture of any desired magnitude up to one kilogram per sq. cm. This makes possible the comparison of rates of capillary movement in different soils under field conditions.

(2) A simple method of removing a portion of soil moisture with the dissolved substances which it contains, thereby enabling a study of the concentration and composition of the soil solution under different field conditions.

This apparatus has the disadvantage of being able to remove water from the soil only when

the latter is comparatively moist; in other words, it fails to give us information regarding the rate of movement of soil moisture during conditions approximating a drouth. Experiments are now in progress with a view to extending the range of the apparatus.

L. J. BRIGGS.
A. G. MCCALL.

PHYSICAL LABORATORY,
BUREAU OF SOILS, U. S. DEPT. OF AGRICULTURE, October 12, 1904.

NOTES ON INORGANIC CHEMISTRY.

THE first fall number of the *Berichte* of the deutschen chemischen Gesellschaft, with its more than six hundred pages, brings an unusually large number of papers on inorganic chemistry. Several of these are of general interest.

IRON HYDROXID AS AN ANTIDOTE FOR ARSENIC.

THE discovery that freshly precipitated ferric hydroxid is an antidote for arsenic was made by Bunsen in 1834, and was the subject of his earliest scientific publication. He attributed the antidotal effect to the formation of a basic ferric arsenite; indeed, by working in an acetic acid solution he obtained a precipitate of such constitution. The suggestion was, however, early made that it was possible that a finely divided powder, of no physiological or chemical action, could under certain circumstances be active as an antidote in cases of poisoning, and large doses of magnesia were found by some physicians to be as efficient as the ferric hydroxid. The whole subject has now been gone over by Dr. Wilhelm Biltz, who finds as a matter of fact that no compound is formed between the arsenic and iron, but that the gelatinous precipitate acts wholly by adsorption. When the iron oxid is present in the proportion of eight parts to one of arsenious oxid, the removal of the arsenic from solution is almost complete. Dr. Biltz offers the suggestion that the action of antitoxins may be susceptible of a similar explanation.

PHOSPHORESCENT ZINC SULFID.

SOME ten years ago a description was published by Henry of the preparation of a brilliantly phosphorescing zinc blende which is known as 'Sidot Blende.' In this preparation one of the essentials was that the zinc used should be chemically pure. In this *Berichte* the subject is taken up by two observers, who independently come to the same conclusion, which is that a good preparation can not be made unless traces of impurity are present. The amount of this impurity should be very small, Grüne obtaining the best results when his blende contained one ten thousandth part of copper. This blende has a beautiful green phosphorescence. Silver, lead, bismuth, tin, uranium or cadmium can be substituted for the copper with good results. Hofmann finds that the best blende can be prepared by adding common salt and magnesium chlorid to a solution of the purest ammonium zinc sulfate, and precipitating with hydrogen sulfid. The unwashed precipitate is then heated to a white heat for half an hour. The resultant blende is composed of fine crystals and phosphoresces after exposure to the sunlight even more intensely than the best 'luminous paint.' Both observers find that when manganese is present as the impurity in the blende, the mass gives an especially beautiful golden yellow phosphorescence, which is also induced by friction, as is the case with some natural blendes. These artificial blendes are particularly valuable for use with radium, but they have no radio-activity of their own.

PLATINUM SULFATE.

SOME time since it was announced by Margules that platinum could be brought into solution in sulfuric acid by the action of the alternating current between platinum poles. At that time the compound formed could not be made to crystallize and its constitution was doubtful. More recently, by using concentrated sulfuric acid Margules has obtained the compound in deep orange-red crystals which are very hygroscopic and excessively soluble in water. These have been analyzed by Stuchlik, and found to be the sulfate of quadrivalent platinum of the composition, $Pt(SO_4)_2 4H_2O$. When the salt has been completely freed from the adherent sul-

furic acid by repeated recrystallization it loses its water of crystallization readily, becoming much darker, but when a trace of sulfuric acid is still present the salt is very stable, hardly changing at 100°.

A NEW CARBID OF MOLYBDENUM.

In his book upon the electric furnace Moissan describes a carbid of molybdenum of the formula Mo_2C. This is formed at the highest temperature of the electric furnace, from a mixture of the oxid of molybdenum and carbon. If an excess of carbon is used, it is found in the mass as graphite. Now by working at a somewhat lower temperature, and having in the furnace the metal molybdenum with a little carbon and an excess of aluminum, a new carbid is formed, of the formula MoC. It is obtained as a gray crystalline powder, harder than quartz but less hard than the ruby. It is not attacked by water even at 600° and hardly by acids except nitric. It is analogous to the carbid of tungsten, WC, and Moissan considers that it is present as a double carbid in molybdenum steel. J. L. H.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MINUTES OF SPECIAL MEETING OF COMMITTEE ON POLICY OF THE ASSOCIATION.

The committee met at Philadelphia, on October 21, at 2 P.M., Messrs. R. S. Woodward, H. L. Fairchild, J. McK. Cattell, Edgar F. Smith and L. O. Howard being present. In the absence of the president, Mr. Woodward took the chair.

The matters referred to the committee by the council at the St. Louis meeting were taken up in order with the following actions:

1. In regard to the disposal of back volumes it was

Recommended, That the permanent secretary be authorized to offer sets of the back volumes of the proceedings to libraries which shall be approved by a committee of the association appointed by the president.

2. The amendment to article 34, of the constitution, relating to the abolition of the $2 fee for fellowship was considered and it was

Recommended, That the amendment be adopted.

3. The amendment to article 4 line 2, to read 'The members of at least one year's standing who are professionally engaged in science and have by their labors aided in advancing science,' was considered, and it was unanimously

Recommended, That the amendment be not passed.

4. The subject of a possible amendment to article 17 of the constitution was considered and action was postponed.

5. The question of trimming the edges of the journal Science, which had been referred to the committee was considered and it was

Recommended, That the publishers of Science be requested to announce prominently that cut copies will be sent to members who request it.

The following new matters were then brought up and the following actions taken:

1. The committee on the policy of the association recommends that two or three addresses of the vice-presidents be given on each afternoon of the week of the meeting and that the addresses be followed by a discussion or series of papers that will be of interest to students of other sciences and to the intelligent public. It is recommended that the addresses before Sections A, E and F be given on Wednesday; before Sections B, G and I, on Thursday, and before Sections C, D and H on Friday. The secretaries and sectional committees are requested to prepare suitable programs to follow the addresses of the vice-presidents.

2. The committee on policy of the association requests the permanent secretary to write a letter to each member of the sectional committees calling attention to the fact that the alteration of the constitution making the term of office five years creates a council for each section. It is hoped that each member will if possible be present at the Philadelphia meeting and before, during and after the meeting endeavor to promote the interests of the section and of the sciences included in it. The sectional committees are expected to make the program as strong as possible, inviting mem-

bers or guests to present papers when this seems desirable and to arrange one afternoon meeting the proceedings of which will be of interest to as many members of the association as possible. They should see that all members of their section professionally engaged in science are proposed for election as fellows, and it will be a great service to the association if they will take an active part in increasing the membership of the association, especially among workers in the sciences included in their section. A list of members of sectional committees should be published in the annual volume and each member of the committee should be informed of the fact 60 days before any meeting.

3. The following resolution was adopted:

Resolved, That the permanent secretary and the secretary of the council and the general secretary be requested to nominate as fellows all members of the association who are members of the following national scientific societies which are assumed to have a qualification for membership equal to the qualification for fellowship in the association: American Society of Naturalists, American Philosophical Society, American Academy of Arts and Sciences, American Anthropological Association, Association of American Anatomists, Association of American Physicians, Association of Pathologists and Bacteriologists, Astronomical and Astrophysical Society of America, Botanical Society of America, Geological Society of America, American Mathematical Society, active members of the American Ornithological Union, American Philosophical Association, American Physical Society, American Physiological Society, American Psychological Association, American Society of Bacteriologists, Society of Plant Morphology and Physiology and the American Zoological Society.

4. The following resolution was adopted:

Resolved, That the committee on the policy of the association recommends as members and, if they become members, nominates as fellows, members of the national scientific societies not now members of the association, in cases in which the national scientific society has a qualification for membership equal to that of the qualifications of the association for fellowship. The following societies are accepted as having such qualifications: (Same list as in resolution 3.)

Resolved, That the permanent secretary be requested to communicate this resolution to each member of these societies, not already a member of the association.

5. The following resolution was introduced by Mr. Woodward and after discussion the permanent secretary on his own motion was requested to have it manifolded and sent to all members of the committee on policy of the association, further consideration to be postponed until a meeting of the committee on policy to be held on Tuesday night, December 27, at hotel headquarters in Philadelphia:

Resolved, That the committee on policy recommends that the Association continue to hold its principal meeting in winter during convocation week, that this meeting be held as a rule in one of the larger cities of the country, and that efforts be made to secure as full a representation of affiliated societies and as large an attendance of members as possible. The committee recommends that in addition arrangements be made for a summer meeting, not necessarily of the whole association, but of such sections and affiliated societies as care to meet together. The place of meeting would be selected with a view to the summer season and with reference to the geographical distribution of members who could not conveniently attend the winter meeting. The following places of meeting are suggested with a view to discussion, since it is important that provisional arrangements be made well in advance for the convenience of the affiliated societies.

Winter.		Summer.	
1904-05.	Philadelphia.	1905.	Ithaca.
1905–06.	New Orleans.	1906.	Ann Arbor.
1906–07.	Boston.	1907.	Berkeley.
1907–08.	Washington.	1908.	Woods Hole.
1908–09.	Chicago.	1909.	Montreal.
1909–10.	New York.	1910.	Madison.
1910–11.	San Francisco.	1911.	Bar Harbor.
1911–12.	Baltimore.	1912.	Columbus.

Dr. Smith, for the local committee for the coming Philadelphia meeting, made a report of progress on the arrangements for the meet-

ing, concerning which there was a general discussion.

After discussion of certain other matters concerning which no action was taken the committee adjourned at 4 P.M.

L. O. Howard,
Secretary.

Washington,
October 23, 1904.

SCIENTIFIC NOTES AND NEWS.

A scientific session of the National Academy of Sciences will be held at Columbia University, beginning on Tuesday, November 15, 1904.

Dr. Charles Baskerville, head of the department of chemistry in the College of the City of New York, has been presented with a loving cup, designed by Tiffany and Company, by his former colleagues and students at the University of North Carolina, on the occasion of the tenth anniversary of his doctorate.

We learn from the *Journal of the American Medical Association* that Dr. George M. Sternberg, Surgeon-General, U. S. A. (retired), has accepted the position of director of the Wills Mountain Sanatorium, situated near Cumberland, Md. The present efficient house staff will be retained. Dr. Sternberg will spend a considerable portion of his time at the sanatorium, which is a health resort for chronic invalids and convalescents.

The department of botany, Columbia University, recently held an informal reception in honor of Professor K. Goebel, of the University of Munich, and Professor Hugo de Vries, of the University of Amsterdam, immediately before their departure for their homes.

At the meeting of the International Association of Academies held in London last May the following special committee was appointed 'to consider as to the best methods of making accurate magnetic observations at sea with a view to carrying out a magnetic survey around a parallel of latitude': Professor von Bezold (chairman), Professor Mascart, Professor Pallazzo, Sir Arthur Rücker, Lord Kelvin, Dr. Bauer, Professor Liznar, General Rykathew, Professor Wiechert, Dr. Paulsen.

Professor Pierandrea Saccardo, of the University of Padua, has been elected a corresponding member of the Reale Accademia dei Lincei of Rome.

Dr. Georg Gaffky, of the University of Giessen, who recently succeeded Dr. Robert Koch as director of the Berlin Institute for Infectious Diseases, has been made an honorary citizen of Giessen in recognition of his services to the public health of the city.

The French Association for the Advancement of Science will hold its annual meeting at Cherbourg in 1905. The officers elected at the recent meeting at Grenoble are as follows: *President,* M. Giard, professor of the theory of evolution at the University of Paris and member of the Institute of France; *Vice-President,* M. Lippmann, professor of physics at the University of Paris and member of the Institute of France; *Secretary,* M. Gaston Saugrain, of the Court of Appeals, Paris; *Vice-Secretary,* M. Carlo, Bourlet, professor of mathematics at the Lycée St. Louis; *Treasurer,* for four years, M. Emile Galanté.

M. Gaston Bonnier, professor of botany at the University of Paris, has been elected a member of the Royal Microscopical Society of London.

Professor Wm. B. Alwood, for sixteen years a member of the faculty of the Virginia Polytechnic Institute, has resigned owing to dissatisfaction with the conditions of scientific work at Blacksburg. He will pursue special investigations at Charlottesville, Va., under direction of the Bureau of Chemistry, U. S. Department of Agriculture.

At the recent celebration of the seventy-fifth anniversary of McGill University, Principal Peterson delivered an address in which he sketched the history of the university and the progress it had made. The lecture served also to honor the anniversary of the birthday of the late Hon. James McGill, its founder.

According to *The Botanical Gazette,* the Imperial Academy of Sciences at Vienna has granted 4,000 Kroner to Professor Julius Wiesner for his journey to the Yellowstone National Park, where he expects to study the light relations of the flora.

THE Royal Society of Sciences at Göttingen has made grants, aggregating 5,600 Marks, to Dr. Brendel to assist in the publication of his edition of the works of Gauss; to Dr. Riecke and Professor Wiechert for the continuation of their researches on atmospheric electricity; to Professor Wiechert for seismological work in the Alps, and to Dr. Wagner for a catalogue of ancient maps.

THE International Surgical Congress, recently in session at Paris, has appointed a committee of specialists to examine the claims of Dr. Doyen that he has discovered a serum curing cancer.

A COMMITTEE has been formed at Copenhagen to collect fund for the erection of a monument to Professor Niels Finsen.

JOHN LIVINGSTON DINWIDDIE BROTHWICK, chief engineer in the United States Navy (retired), died from nervous prostration, at Florence, on October 22, at the age of sixty-four years.

The British Medical Journal states that the legacy of £25,000 left by the late Professor Puschmann, of Vienna, to the University of Leipzig, is to be applied to the study of the history of medicine. It is proposed to found a historical museum of medicine, and a special seminary for training persons in medico-historical research and in historiography, with a salaried director and assistant. The names of Dr. Sudhoff and Dr. von Oefele have already been suggested, both eminent in the science of the history of medicine. Professor Puschmann was professor of the history of medicine at Leipzig until 1879, when he accepted a call to a similar chair at Vienna. He died in 1899, and his will was at first contested, but the money has now been paid to the university.

THE annual meeting of the British Iron and Steel Institute is being held in New York City this week. About 350 members and guests were expected to be present.

The British Medical Journal states that the foundation of a German Physiological Society is one of the outcomes of the meeting of German Men of Science and Physicians recently held at Breslau. Professor Schenk, of Marburg is president and Professor Hürthle, of Breslau, treasurer of the new society. The first meeting of the society will be held at Marburg at Whitsuntide, 1905.

WE learn from the *Bulletin of the American Mathematical Society* that an effort is being made to establish a society for the study of the history of the natural and technical sciences. The subject was presented at the Third International Congress of Mathematics at Heidelberg last August, and at the International Congress of Philosophy at Geneva in September and attracted favorable attention. Those who are interested in the founding of such a society are asked to communicate at an early date with Ingenieur F. M. Feldhaus, Rohrbach, Heidelberg, Germany.

THE University of Washington proposes to establish a permanent marine station at a point, yet to be decided on, at Puget Sound. During the present summer a temporary station was established at Friday Harbor, in charge of Professor Trevor Kincaid and Dr. T. C. Frye.

DR. ALEXANDER F. CHAMBERLAIN, of Clark University, Worcester, Mass., and William Wallace Tooker, of Sag Harbor, Long Island, are engaged upon a work to be entitled, 'The Proverbs of Solomon, King of Israel. From Eliot's Indian Bible. With Introduction, Notes and Vocabulary.' This is the first attempt to make accessible to scholars and to the public in general any considerable portion of this famous book. The tercentenary of Eliot's birth occurs in 1904 and the 'Book of Proverbs' in this dress will be one of the many tributes to the memory of the 'Indian Apostle.' The difficulties of the work are such that no date of publication can be fixed.

THE London *Times* states that it never uses the same type twice. Every day a new supply is delivered at its offices by the Wicks Rotary Type-Casting Company, amounting on the average to as many as a million letters; and the whole of it is removed on the following day to be put into the melting-pot. Such lavishness could only be possible with type made at extraordinary speed and with exceptional cheapness, and the invention that first

realized these aims was the work of Mr. Wicks, who, curiously enough, is not an engineer by profession, but a journalist, and was formerly a member of the gallery staff of *The Times*. His original invention has been vastly improved in the course of years, and the members of the Civil and Mechanical Engineers' Society, who, headed by the honorable secretary, Mr. A. S. E. Ackermann, paid a visit on August 4 to the works at Willesden where the type-casting wheels are made, spent a couple of very interesting hours among machines and contrivances which strike laymen as little short of magical, but can only be properly appreciated by engineers. Under the guidance of the firm's engineer, Mr. E. G. Tottle, they inspected every process of the manufacture of the punches, the matrices, and the type-casting wheel itself; and, though the actual casting is done at the works in Blackfriars, arrangements had been made by which the operation of one of the finished wheels could be exhibited. Before the invention and perfection of this wheel a type-making machine which could turn out 6,000 types an hour was considered rapid; the Wicks rotary wheel casts 60,000 with ease, and 40 per cent. more cheaply than the old machines. The firm's engineer explained that, after buying the best and most expensive machine in the market, they invariably set to work to alter it until it reached their own standard accuracy. All the calculations (and they are peculiarly complicated, since, to comply with the traditions of printing, the unit is 1-72 part of an inch) are carried out to six places of decimals, and the men who grind the punches or make the wheels work to 1-10,000 part of an inch. The care taken and the quality of the machinery employed may be gauged by the fact that the little punch-cutting machines, which each cost nearly £1,000, are bedded, to avoid vibration, on a depth of 16 feet of concrete, which in its turn is laid on oak piles 5 feet long.

According to foreign papers several parts of Paris are so infested with mosquitoes that the matter of their suppression has been considered by the Conseil d'Hygiène et de Salubrité de la Seine, which recently adopted certain conclusions of which the following is a summary: In the first place stagnant water where their eggs are hatched and localities where the insects collect, such as cellars, sewers and dark places, ought to be kept under observation. Drains and sewers of all kinds, and the openings of the pipes which supply water in the streets, should be regularly inspected to avoid collections of stagnant water, and insects assembling in numbers should be destroyed either by a burning torch or by lime-washing. Roofs and rain-water gutters ought to be examined, and water ought not to be allowed to lodge in the gutters. Nothing capable of holding water should be placed in front of windows, and places which are the haunts of mosquitoes should be well ventilated. Stagnant water should not be allowed to remain in gardens and courtyards. Fountains and basins in public places should be emptied and cleansed at least once a week, and plenty of fish should be kept in large sheets of water. In basins and casks standing on private ground there should be a layer of petroleum oil on the surface of the water (about a gram per square meter), or if the water contains fish a layer of salad oil. The public should be advised to use mosquito curtains. Mosquito bites should be treated with a drop of tincture of iodine or with a drop of a solution of guaiacol of one per cent. strength.

Reports received by the United States Geological Survey for 1903 show that many springs that were formerly used as sources of table waters were commercially abandoned during the previous year. The reports also show a decided loss in the number of gallons of water sold and also in the value of the product—losses ascribed mainly to the fact that many important springs failed to report for the year 1903, although they sent in returns for the previous year. These losses occur in all sections except one. The list of mineral springs reported for 1903 is slightly increased over that of 1902, including now 725 springs instead of 721 as in 1902. The list has been lengthened by the addition of 42 new names. The number of springs dropped from the list, because commercially abandoned, is 38. The springs actually reporting sales for 1903 number 522, which is

127 less than the number reporting in 1902. The springs not heard from number 167, and these, with few exceptions, reported sales in 1902. In addition there are 36 springs which report that no sales were made in 1903, thus increasing the number of delinquents to 203. The average price for a gallon of mineral water is about 16 cents for 1903, as compared with 13.7 cents for 1902. The total production for 1903, including the figures estimated for the delinquent springs, is 50,575,746 gallons, at a valuation of $8,074,096. This is a loss in quantity of 14,283,715 gallons and in value of product of $719,655, as compared with the production of 1902. When the 522 springs actually reporting are alone considered, the figures are 37,707,647 gallons, as compared with 63,174,522 gallons in 1902, a loss of 25,466,905 gallons; and a valuation for 1903 of $6,382,726, compared with $8,634,179 in 1902, a loss of $2,251,453. It is probable that a loss would be shown even had all the springs now delinquent sent in returns. The survey report from which these figures are taken is an extract from the forthcoming volume 'Mineral Resources of the United States, 1903,' and may be obtained, free of charge, from the Director of the United States Geological Survey, Washington, D. C.

THE new number of the quarterly *Bulletin* of the Imperial Institute contains, according to the London *Times*, a number of valuable reports by the scientific and technical department on recent investigations of various British products, undertaken with a view to ascertain their present or potential applicability to commercial needs. An examination of sisal, banana and pineapple fibers from southern Rhodesia, and their submission to commercial experts, has led to the conclusion that they would sell freely in the London market, at remunerative prices, if imported regularly in bulk. Another report shows that Bermuda is capable of becoming a competitor with the foreign countries, chiefly Syria and Caucasian Russia, on which we now depend almost exclusively for our imports of liquorice root. The Bermuda product would occupy an intermediate position between the coarse Syrian and the fine Caucasian root. Leathers from Pemba tanned with local mangrove barks have been found to be suitable for the manufacture of cheap boots, and it is suggested that a remunerative expert trade might be initiated at Zanzibar, in competition with the lower grades of American and Australian leather in demand in this country. Cacao, cotton and honey samples from Trinidad have been favorably reported on, the cacao being quite equal to the highest qualities in the English market. Though found to be incompletely soluble in 70 per cent. alcohol, lemon-grass oil from Montserrat would, it is stated by dealers in essential oils, find a ready sale here and on the continent. There would also be a continental demand, though probably not a home demand, for seeds of the 'physic-nut' tree (*Jatropha Curcas*) of Lagos, as the oil extracted could be employed for soap making. Five of the reports relate to the rubber production of the Empire. One of them gives the results of analyses of rubbers and rubber vines received from Takaunga, the Kamasia Hills and Rabal, in the East Africa Protectorate, while another deals with the *Urceola esculenta* of Burma. The conclusion in respect to the plant is that it will yield marketable rubber of good quality, and the shipment of a trial consignment to this country is recommended. A sample of 'pontianac' obtained from the state forests of Patiala was found to correspond closely with the 'pontianac' extensively used in the United States, and to be equally suitable for utilization in this country in the manufacture of low-grade rubber goods. In addition to the reports referred to, various general notices are given respecting economic products and their development, together with a detailed description of the eucalyptus oils of New South Wales, as illustrated by an extensive exhibit now open to the public and presented to the institute by the Technological Museum of Sydney.

UNIVERSITY AND EDUCATIONAL NEWS.

THE will of Mr. James Callanan, of Des Moines, makes bequests for educational institutions as follows: Talladega College, Alabama, $100,000; Casenovia College, New York, $5,000; Penn College, Oskaloosa, Iowa, $10,-

000; Des Moines College, $5,000; Wilberforce University, Green, O., $5,000; Ambidexter Institute, Springfield, Ill., $10,000.

The *Educational Times* states that of the £170,000 required for the endowment of Sheffield University nearly £110,000 has been collected or promised. The Duke of Norfolk, who is named as the chancellor of the new university, has given £10,000. All classes of the community have contributed freely. The claims of the scheme are being advocated in the large towns near Sheffield, such as Rotherham, Doncaster, Barnsley and Chesterfield, on the support of which the stability of the university largely depends. It is essential to the success of the scheme that the public grants should be largely increased. The Sheffield city council now supports the technical department of the college to the extent of about £5,000 a year, but has promised, if the charter is granted, to make a yearly contribution to the arts, science and medical departments of a sum not exceeding the revenue of a penny rate, which is expected to produce some £6,700 a year, or about £5,000 more than the council now pays to those departments. The West Riding county council has set aside £6,000 a year for the universities in Yorkshire. This sum has not yet been divided between Leeds and Sheffield. In addition, it is anticipated that the Derbyshire county council, as well as some of the surrounding local authorities, will contribute.

At a recent meeting of the Harvard faculty, it was voted to change the requirements for the degree of A.M. and to allow undergraduates who have completed the requirements for the degree of A.B., with the exception of a single course, to be admitted to the graduate school as candidates for A.M.

The following appointments and promotions have been made at the College of Physicians and Surgeons, Columbia University: Dr. Gorham Bacon, professor of otology; Dr. Joseph A. Blake, professor of surgery; Dr. George E. Brewer, professor of clinical surgery; Dr. Frederick R. Bailey, adjunct professor of normal histology; Dr. Arnold Knapp, professor of ophthalmology; Dr. Eugene Hydenpyl, adjunct professor of pathological anatomy; Dr. Frederick Peterson, clinical professor of psychiatry; Dr. Francis Carter Wood, adjunct professor of clinical pathology, and Dr. Russell Burton-Opitz, adjunct professor of physiology.

Mr. James Walter Goldthwait, of Lynn, Mass., has been appointed instructor in geology at Northwestern University. Mr. Goldthwait took his undergraduate and his graduate work at Harvard University, where he was also one of the corps of instruction.

The following appointments have been made to the teaching force of the Michigan College of Mines, Houghton, Michigan: Arthur Alexander Koch, Ph.D., University of Basel, instructor in chemistry; Charles Franklin Bowen, M.S., University of Wisconsin, and Eugene Thomas Hancock, B.S., University of Wisconsin, instructor in geology and mineralogy; Charles Hamilton Hoyt, C.E., Thayer College of Engineering, instructor in civil and mining engineering; Durward Copeland, B.S., Massachusetts Institute of Technology, instructor in metallurgy and ore dressing.

W. L. Powers, Cornell College, '03, has been appointed assistant in inorganic chemistry in the Medical College of Sioux City.

Dr. William Palmer Wynne, D.Sc. (Lond.), F.R.S., senior honorary secretary of the Chemical Society and professor of chemistry in the School of Pharmacy of the pharmaceutical Society, has been appointed to the Firth chair of chemistry in University College, Sheffield, in succession to Professor Carleton Williams.

Dr. Albert S. Grünbaum, lecturer in experimental medicine in Liverpool University and director of the Liverpool Cancer Research, has been appointed professor of pathology and bacteriology.

Mr. J. J. Lister, M.A., fellow of St. John's, Cambridge University, has been appointed demonstrator of comparative anatomy until Michaelmas, 1905.

At the University of Brussels, Drs. G. Dwelshawers and R. Berthelot have been promoted to full professorships of philosophy and Dr. Stroobant to a professorship of astronomy.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 4, 1904.

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THE PHYSICAL PROPERTIES OF AQUEOUS SALT SOLUTIONS IN RELATION TO THE IONIC THEORY.*

IT is generally recognized that the further progress of physical science will be greatly facilitated by a better systematization of the knowledge already accumulated, and this is true in an especially high degree of the newly developed branch of science in which this section is directly interested. It has, therefore, seemed to me that the most valuable contribution that I could make toward the solution of the present problems of physical chemistry in correspondence with the aims of this Congress, would be a formulation of the present status of some of our knowledge relating to important classes of phenomena which are being actively investigated, but which have not yet received a final interpretation. It was my original hope to discuss several such classes of phenomena; but the effort involved in the collation and criticism of the available data connected with the problem which was first studied, forced me to confine my attention to that alone. This problem concerns *the physical properties of aqueous salt solutions in relation to the ionic theory.* This is the subject which I shall attempt to present to you: I hope that its importance and the greater definiteness that can be given to its treatment may compensate for the somewhat limited scope of this paper.

Permit me to say in advance that I have

* Address delivered at St. Louis before the Section of Physical Chemistry of the Congress of Arts and Science.

studied this subject primarily from an empirical standpoint, and that it will be my aim to present to you a series of generalized statements of the experimental results, formulated in such a way as to show their relation to the important hypotheses connected with the ionic theory. Unfortunately, it will not be possible in this address to reproduce, or even fully refer to, the data upon which these conclusions are based—a defect serious in a work of this kind, which will be remedied in a subsequent publication. I shall, however, try to show the general character of the evidence for each conclusion, and the degree of accuracy within which it has been confirmed. I wish to add that I have been most ably assisted in the preparation of the material upon which paper is based, by Dr. J. W. Brown and Dr. M. S. Sherrill, of the Massachusetts Institute of Technology.

The principles to be first presented have reference to two of the main hypotheses which are commonly employed in quantitative applications of the ionic theory. One of these hypotheses is that *the migration-velocities of the ions of a salt do not vary appreciably with its concentration, at least up to a moderate concentration; and consequently, that the degree of ionization is equal to the ratio of the equivalent conductivity at the concentration in question to the limiting value of the equivalent conductivity at zero concentration*—a ratio which I will hereafter call simply the conductivity-ratio. The other hypothesis is that *ions, and also the un-ionized molecules accompanying them, produce an osmotic pressure substantially equal to the pressure exerted by the same number of gaseous molecules at the same temperature, at least up to a moderate concentration;* a hypothesis which may be more briefly expressed by the statement that the osmotic-pressure constant for dissolved electrolytes is identical with the gas-constant. It is evident that with the help of this hypothesis we can calculate, either from measurements of osmotic pressure or from those of any other property which is thermodynamically related to osmotic pressure, the number of mols in the solution resulting from one formula weight of salt, that is, the quantity which van't Hoff has represented by the letter i. From the latter, provided the ionization is not complicated by the formation of complex molecules or ions, the degree of ionization is readily derived.

The first of these hypotheses can not be independently tested, because no direct method of determining the change of migration-velocity with the concentration, is known. But the following principle, which has an important significance with reference to the *relative* influence of concentration on the velocities of different ions, has been established by measurements of the concentration-changes at the electrodes attending the electrolysis of salt solutions.

The transferrence number, or ratio of the conductivity of one ion to the sum of the conductivities of both ions, is constant within one per cent., between the concentrations of 1/200 *and* 1/10 *normal, for all salts thus far accurately investigated, except lithium chloride, the halides of bivalent metals and cadmium sulphate.*

This principle holds true, according to the results of various investigators, in the case of potassium and sodium chlorides, hydrochloric and nitric acids, silver nitrate, barium nitrate, potassium sulphate and copper sulphate—thus in the case of salts of the three different ionic types, which I will speak of as the uni-univalent, the uni-bivalent and the bi-bivalent types, in correspondence with the valences of the two ions composing the salt.

Two conclusions are to be drawn from this result. The first is that complex ions are not present in important quantity in

the solutions of these salts. And the second is that the migration velocities of the two ions of a salt vary by the same percentage amount, if they vary at all, with changes in its concentration. It is scarcely admissible, however, to regard this last fact even as an indication that the hypothesis of constant migration velocities is correct; for any change in the character of the liquid medium might well affect the velocities of different ions not far from equally.

Important evidence in regard to this hypothesis and that stating that ions and the un-ionized molecules associated with them have a normal osmotic pressure is, however, furnished by the agreement of the ionization values derived, on the one hand, from the conductivity-ratio, and, on the other, from the properties thermodynamically related to osmotic pressure. Three of these properties have been measured with sufficient accuracy with certain electrolytes to make the results of significance, namely, the freezing-point lowering, the electromotive force of concentration cells, and the heat of solution in relation to change of solubility with the temperature. Under the assumption that osmotic pressure and gaseous pressure are equal under identical conditions, a relation between each of these properties and the degree of ionization of an electrolyte can be derived with the help of the second law of energetics. Then, either this ionization value may be directly compared with the conductivity ratio; or, assuming provisionally that the latter is a correct measure of ionization, the magnitude of the property in question may be calculated, and the result compared with that obtained by direct measurement. In the case of the freezing-point lowering, I have adopted the first of these methods. For the five salts for which both reliable freezing-point determinations and accurate conductivity measurements at 0° exist, the ionization values corresponding to both of these properties have been computed. Especial attention was given to the selection of the best value of the freezing-point lowering constant and to the extrapolation of the conductivity for zero concentration, the details of which can not be here described. The results may be summarized as follows:

In case of the two uni-univalent salts and the three uni-bivalent salts hitherto carefully investigated, the ionization values derived from freezing-point lowering do not differ from those derived from conductivity, between the concentrations of 1/200 *and* 1/4 *normal, by more than two or three per cent.*

The five salts referred to are potassium and sodium chlorides, potassium and sodium sulphates and barium chloride. The two sets of values for potassium chloride, for which an abundant experimental material exists, exhibit no pronounced or systematic differences; but for the other four salts the freezing point leads to values which are in general from two to three per cent. higher at all concentrations than the conductivity ratio. The fact that these differences do not, as a rule, increase with increasing concentration indicates that they may be due to some constant experimental error, or to an error in the extrapolated conductivity value.

Accurate measurements have been made by Jahn of the electromotive force of concentration cells consisting of two silver or mercury electrodes covered with silver chloride or mercurous chloride, one of which is immersed in a weak solution and the other in a strong solution of sodium or potassium chloride. These measured values were compared by him with those calculated from the thermodynamic relation between electromotive force and the concentrations and degrees of ionization of the salt in the cell. Unfortunately, however, the thermodynamic relation employed in-

volved the assumption that the ionization varies with the concentration in accordance with the mass-action law—an assumption which is known not to be true of the ionization values derived from conductivity. The assumption is, therefore, an irrational one—one by which the question at issue is prejudged. What should be done in calculating the electromotive force so as to determine whether the conductivity ratio gives ionization values consistent with the measured electromotive forces, is evidently to assume that the ionization changes with the concentration in the way that the conductivity indicates that it does. Arrhenius recognized this error and partially corrected for it by a method of approximation. I have repeated the calculations by an exact thermodynamic formula based on an empirical law expressing the change of the conductivity ratio with the concentration, to which I will refer later. The results are summed up in the statement that, *when the conductivity-ratio is assumed to represent the degree of ionization of the salt, the calculated values of the electromotive force of concentration cells exceed the measured ones by only about one per cent. in the case of potassium and sodium chloride between the concentrations of* 1/600 *and* 1/20 *normal.* The measured electromotive force corresponds to an ionization value at the latter concentration about one per cent. less than the conductivity ratio.

The thermodynamic relation involving heat of solution has been accurately tested with only one salt—potassium perchlorate; but since it is a different salt from those used in the other experiments and since its concentration was fairly high—one eighth normal—the result is of interest. It was found that the *measured heat of solution was less by only 1.1 per cent. than that calculated under the assumption that the conductivity ratio is equal to the degree of ionization.* The measured heat of solution corresponds to an ionization value 2½ per cent. lower than the conductivity ratio.

With respect to these small deviations of the results obtained by the three methods of comparison, it is important to note that they lie in opposite directions, the freezing-point lowering corresponding to larger values of the ionization, and the measured electromotive forces and heat of solution to smaller ones than the conductivity-ratio. This fact makes it almost certain that they are due to experimental errors. Nevertheless, further exact measurements of all these properties are highly desirable.

From a theoretical standpoint these three methods are based on the same hypotheses, namely, that the osmotic pressure constant for ions and un-ionized molecules is identical with the gas-constant; that the conductivity-ratio is a correct measure of ionization, and that complex molecules or ions are not present in the solution. The concordance of the results furnishes, therefore, a strong confirmation of the correctness of these fundamental hypotheses. The only alternative conclusion is that an error in one of these hypotheses is compensated by an error of opposite effect in one of the others; but it seems very improbable that such a compensation could occur in the case of so many salts of different chemical nature and different types through the range of concentration (1/200–1/4 normal) for which the agreement of the experimental results has been shown to hold true. It is certainly more consistent with the modern methods of science to adopt these simpler hypotheses which are in full accord with the considerable number of facts thus far known, than deliberately to introduce more complicated assumptions for which there is at present no experimental warrant.

The combination of these hypotheses with the experimental values of the quantities involved at varying concentrations makes

necessary the further conclusion that the *degree of ionization of salts, whether derived from the conductivity-ratio or from thermodynamic relations involving the equality of the osmotic pressure constant and the gas constant does not vary with the concentration even approximately in accordance with the law of chemical mass action.*

This empirical consequence of the fundamental hypotheses of the ionic theory has led several investigators to raise a theoretical objection to them, it being contended that the laws of thermodynamics require that the validity of these hypotheses involves that of the mass action law itself. This apparent inconsistency between the inductive and deductive conclusions makes it probable that some unproved, erroneous assumption is tacitly involved in the theoretical derivation. That there is in fact a possible alternative, which has, I believe, been previously overlooked in the thermodynamic discussions, will be evident from the following considerations. The thermodynamic relations between ionization and freezing point, electromotive force, or heat of solution involve only the assumption that the work done in reversibly separating water from a solution at constant concentration is equal to that done in producing the same volume-change in a gas, which implies, of course, that the ions and un-ionized molecules have in the presence of each other normal osmotic pressures. On the other hand, the derivation of the mass action law equation is based on cyclical processes which necessarily involve the separate introduction and removal of the un-ionized molecules and of the ions into or from solutions of different concentrations, and it further involves the assumption that this introduction or removal of molecules or ions can be effected by the application of an external pressure equal to that osmotic pressure which each of them possesses in the mixture, that is, the possibility is ignored that the separation of the molecules from the ions may itself give rise to some new force, and may involve, consequently another quantity of work than that corresponding to the osmotic pressure. The ionic theory would evidently predict a result of this kind if an attempt were made to separate the positive ions from the negative, even though their osmotic pressures when present together were perfectly normal; and it is quite conceivable, even though the reason for it be not apparent, that the separation of the un-ionized molecules from the ions, with which they may be in electrical as well as chemical equilibrium, should involve an abnormal quantity of work. The assertion that the validity of the osmotic pressure principle necessarily implies that of the mass action law is, therefore, unwarranted from a deductive standpoint; while the inductive evidence, pointing strongly as it does to the substantial correctness of the former principle and the complete inadequacy of the latter one, makes it highly probable that the *separation of un-ionized molecules from ions does involve the expenditure of other work than that corresponding to their osmotic pressures.*

Since the ionization does not change with the concentration in accordance with the mass action law, it is natural to inquire what the law of its change is. This matter has been investigated from an empirical standpoint by several investigators with the help of the conductivity data. The results justify the statement of the following principles:

The un-ionized fraction of a salt as determined from the conductivity ratio is proportional to the cube-root of its total concentration or to that of its ion-concentration, between 1/2,000 *and* 1/10 *normal, in the case of both uni-univalent and uni-multivalent salts.* That is, $1 - \gamma = Kc^{\frac{1}{3}}$

or $1-\gamma = K(c\gamma)^{\frac{1}{2}}$ where γ is the degree of ionization, c the concentration, and K a constant. The first of three functions was proposed by Kohlrausch, the second by Barmwater. Owing to the relatively small variation of the ionization, these two functions can not differ much as to their constancy, but on the whole the experimental data indicate that the second function is somewhat more constant. The average deviations of the actual measurements from the values corresponding to this function are $\frac{1}{4}$ per cent. in the case of ten uni-univalent salts, $\frac{1}{3}$ per cent. in the case of nine uni-bivalent salts and also $\frac{1}{3}$ per cent. in the case of three uni-tri and uni-quadrivalent salts. The maximum deviations are two or three times as great. It is of interest to note that the strong mineral acids, hydrochloric and nitric, behave like salts in this respect. These functions have been shown to apply to potassium and sodium chlorides through a range of temperature extending from 18° to 306°. They do not apply at all closely to such salts of the bi-bivalent type as magnesium and copper sulphates, perhaps owing to appreciable hydrolysis. Nor do they represent satisfactorily the experimental data for any kind of salts at the very low concentrations lying between 1/100,000 and 1/2,000 normal, nor at concentrations higher than 1/5 normal.

The experimental results are also well expressed by the statement that *in the case both of uni-univalent and uni-bivalent salts between the concentrations of* 1/10,000 *and* 1/5 *normal, the concentration of the un-ionized molecules is proportional to the concentration of the ions raised to a constant power, varying somewhat with the salt and the temperature, but as a rule only between the limits of* 1.43 *and* 1.56. That is,

$$c(1-\gamma) = K(c\gamma)^n, \text{ where } n > 1.43 \text{ and } < 1.56.$$

This general function was first applied by Storch, and was afterwards further discussed by Euler and Bancroft. It has the advantage over the previous ones that it represents the data with accuracy even up to the highest dilutions, and therefore can be used for obtaining the limiting conductivity at zero concentration.

The applicability to the salts of different types of either of these principles governing the change of ionization with the concentration leads to the important conclusion that *the form of the concentration function is independent of the number of ions into which the molecules of the salt dissociates.* This remarkable fact, though previously recognized, has not been sufficiently emphasized, and it has been often ignored in discussions of the cause of the deviation of the ionization of salts from the requirements of the mass action law. It seems to me to show almost conclusively that chemical mass action has no appreciable influence in determining the equilibrium between ions and un-ionized molecules. How complete the contradiction with the mass action law is, may be illustrated by citing the specific facts that for di-ionic, tri-ionic and tetra-ionic salts this law requires that the concentration of the un-ionized molecules be proportional to the square, the cube, and the fourth power, respectively, of the concentration of the ions, while the experimental data show that it is approximately proportional to the 3/2 power of that concentration, whatever may be the type of salt.

Having seen in what manner the degree of ionization varies when the concentrations of both ions of the salt are simultaneously varied by dilution, it is of interest to determine the effect of changing the concentration of either ion separately. A study of the conductivity and the freezing-point of mixtures of two salts having one ion in common throws much light upon

this question, for the following simple principle has been found to represent this phenomenon: *The conductivity and the freezing-point lowering of a mixture of salts having one ion in common are those calculated under the assumption that the degree of ionization of each salt is that which it would have if present alone at such an equivalent concentration that the concentration of either of its ions were equal to the sum of the equivalent concentrations of all the positive or negative ions present in the mixture.*

This somewhat complicated statement may be illustrated by the following example: Suppose that a mixed solution is 0.1 normal with respect to sodium chloride and 0.2 normal with respect to sodium sulphate, and that it is 0.18 normal with reference to the positive or negative ions of these salts. The principle then requires that the ionization of either of these salts in the mixture be the same as it is in water alone when its ion-concentration is 0.18 normal.

This principle in regard to the conductivity of mixtures, which has been definitely stated by Arrhenius, is shown by the existing data to hold true almost, if not quite, within the small experimental error of the determinations both for mixtures of salts of the same type and for those of salts of different types up to a concentration of at least 1/2 normal. Experiments confirming this principle have been made upon eight pairs of uni-univalent salts by Arrhenius, Manson and Barmwater. In addition, the principle has been shown by several Canadian investigators, Archibald, McKay and Barnes, to hold true for mixtures of potassium and sodium sulphates, potassium and copper or magnesium sulphates (up to 0.1 normal), potassium sulphate and chloride, barium and sodium chlorides, and zinc and copper sulphates—thus for almost every possible typical combination of uni-uni, uni-bi and bi-bivalent salts. That the same principle is true of the freezing point lowering is shown by the measurements of Archibald with mixtures of potassium and sodium sulphate. This proves that the phenomenon really has reference to the degree of ionization and that it does not arise from a possible variation in the migration-velocities of the ions.

Of special interest is the relation of this principle to the validity of the mass action law. Almost all investigators of the conductivity of mixtures have concluded from the fact that upon mixing solutions of equal ion-concentration there is no change in ionization, that the results do conform to this law. Yet it is scarcely conceivable that this law can apply to mixtures of salts in which the concentration of one ion is varied while maintaining that of the other constant, in view of the fact that it is known not to hold true for the variations of the concentrations of both ions produced by dilution. And in reality this conclusion, if regarded as a general expression of the facts, is entirely unwarranted. It is true that for certain typical combinations of salts—those for which from one molecule of each salt results by ionization not more than one ion of the kind not common to the salts—the principle here stated does coincide with the requirements of the mass-action law. But for combinations not so characterized the mass-action law predicts, as is readily seen upon formulating the equations, a conductivity of the mixture widely divergent from that actually found, and, therefore, from that expressed by the principle under consideration. This last statement applies, for example, to the mixtures before referred to of potassium sulphate with sodium sulphate, and of potassium sulphate with copper or magnesium sulphate, the first of which have been studied with respect both to their conductivity and freezing point.

The law of chemical mass action here again shows itself entirely inapplicable to the phenomena connected with the ionization of salts. That some investigators have thought that the deviations from this law indicated by the conductivity were only apparent, and that they were attributable to variations in the migration velocity, has arisen, no doubt, from the fact that they have confined their attention to di-ionic salts, and have failed to recognize, on the one hand, the striking divergences from it exhibited by tri-ionic salts, and, on the other, the substantial correspondence of the conductivity and freezing-point results.

Combining this principle in regard to the ionization of mixed salts in solution with the empirical concentration law of Storch for single salts, we are led to the conclusion that the ratio of the concentration of the un-ionized part to the product of the concentrations of the two ions (but in the case of tri-ionic salts *not* raised to a power corresponding to the requirements of the mass action law) is a function of the sum of the equivalent concentrations of all the ions in the solution and of that alone.* This ratio is, moreover, roughly inversely proportional to the square root of the total ion-concentration.

The correctness of this principle is further demonstrated by the fact that with its aid, also, the conductivity of a mixture of two salts without a common ion can be computed from their separate conductivities. This is shown by the conductivity measurements, made by Archibald and more recently by Sherrill, upon mixtures of potassium chloride and sodium sulphate, or of sodium chloride and potassium sulphate. Up to at least 0.2 normal concentration, the agreement between the observed and calculated values is within 0.5 per cent. On the other hand, the divergence of the observed values from the requirement of the mass-action law amounts to many per cent.

It seems appropriate at once to supplement these principles in regard to the form of the concentration function by a statement of two general rules which have been found to express the magnitude of the ionization of salts of different types. These rules, unlike the preceding principles, are only crude approximations; but, nevertheless, they prove of some assistance in rough applications of the ionic theory, and undoubtedly possess an important theoretical significance, not yet recognized. They may be stated as follows: (1) *The decrease of ionization with increasing concentration is roughly constant in the case of different salts of the same type; and* (2) *the un-ionized fraction at any definite molal concentration is roughly proportional to the product of the valences of the two ions in the case of salts of different types.* Thus, at 0.1 normal concentration the mean value of the degree of ionization for 17 uni-univalent salts measured at 18° is 83.3 per cent., the average deviation of the separate values from this mean is 2.1 per cent., and the maximum deviation of any of them is 5.4 per cent. of the mean value; while for fourteen uni-bivalent salts the mean value is 69.8 per cent., the average deviation 5 per cent. of this, and the maximum deviation about 10 per cent. of it. The un-ionized fraction in 1/20 molal solution is 13½ per cent. for these univalent salts; 30 per cent., or about twice as great, for the uni-bivalent salts; and 60 per cent., or about four times as great, for the three bi-bivalent salts investigated (zinc, magnesium and copper sulphates). The salts of mercury

* This is expressed mathematically by the following equation, in which c_1 and c_2 represent the equivalent concentrations of the two salts, and γ_1 and γ_2 their degrees of ionization in the presence of each other:

$$\frac{c_1\gamma_1(c_1\gamma_1 + c_2\gamma_2)}{c_1(1-\gamma_1)} = K_1(c_1\gamma_1 + c_2\gamma_2)^{n-1}$$

and cadmium are pronounced exceptions to the rule.

A far more extensive material for testing these rules is furnished by the measurements made at 25° between the concentrations of 1/32 and 1/1024 normal. In the case of the uni-univalent salts, data exist at this temperature and these concentrations for 36 inorganic salts, about 65 sodium salts of organic acids, and about an equal number of hydrochlorates of organic bases. A consideration of all these data shows that, with only three or four exceptions not of a pronounced character, the values of the degree of ionization of all these salts in 1/32 normal solution lie between the limits of 84 and 90 per cent. and are fairly uniformly distributed throughout this range of 6 per cent. For 67 uni-bivalent salts the corresponding limits of the ionization values are 72 and 81 per cent. while for only four such salts do the values lie beyond these limits. For the 6 uni-trivalent salts investigated the range is from 67 to 76 per cent.; for the three uni-quadrivalent salts, from 59 to 63 per cent.; and for twelve bi-bivalent salts, from 49 to 63 per cent., while three such salts show more considerable variations. The values of the un-ionized fraction corresponding to the mean of these two limits for the different types of salts at the same equivalent concentration increase somewhat more slowly than the product of the valences of the ions. The proportionality becomes a fairly close one, however, when the salts are compared at the same molal, instead of the same equivalent concentration. Thus, with the help of the Kohlrausch concentration-function, it is calculated from the preceding values that the un-ionized fractions in 1/32 molal solution are as follows: 13 per cent. for the uni-univalent salts, 29½ per cent. for the uni-bivalent salts, 41 per cent. for the uni-trivalent salts, 62 per cent. for the uni-quadrivalent salts, 55 per cent. for the bi-bivalent salts, which are seen to be approximately the required multiples of the constant factor 14.

Before leaving this subject it should be stated that the results conform, on the whole, about equally well with the rule that *the decrease of equivalent conductivity (instead of ionization) is roughly constant for salts of the same type;* and when the comparison is made at the same equivalent concentration, distinctly better to the rule that the *decrease of equivalent conductivity is proportional to the product of the valences of the ions for salts of different types.* (When compared at the same *molal* concentration, however, this rule does not apply.) These rules were originally stated by Ostwald. They differ not inconsiderably from those expressing the change in ionization, namely, to an extent corresponding to the variations of the conductivities at extreme dilution. The deviations are so irregular, however, that from an empirical standpoint the choice between the two pairs of rules is arbitrary. In either form these rules seem to justify the inference that the degree of ionization of salts, unlike that of the organic acids and bases, is not primarily a specific chemical property determined by chemical affinity, but that it is determined, at least in the main, by the magnitude of the electric charges on the ions.

The establishment of the principle in regard to the ionization of a mixture of salts has a direct bearing on the phenomenon of the effect of one salt on the solubility of another with a common ion. It has been usually assumed that in a (not too concentrated) saturated solution the un-ionized molecules of the salt always have the same concentration, and secondly that the product of the *ion*-concentrations (each raised to a power corresponding to the number resulting from one molecule) also retains the same value. And the experimental results

in several cases have been shown to accord fairly well with these two hypotheses. Yet their simultaneous validity is quite inconsistent with the principle in regard to the ionization in mixtures. In fact, when considered in the light of this principle, the existing data lead to the conclusion that the former hypothesis is not even approximately true, and that the latter one, at any rate in cases where the ionization is far from complete, is affected by a considerable error. One example may be cited: when thallium chloride and bromate, each of which alone has a solubility of about 1/40 normal in water at 40°, are simultaneously present as solid phases, the solubility of each is reduced by the other to an extent which shows that the concentration of the un-ionized molecules is diminished by about 15 per cent. and that the product of the ion-concentrations is increased by about 5 per cent. This case is a typical one; but what the quantitative law of the influence in question is, can only be determined by a further study of the phenomenon. In the case of tri-ionic salts, the ion-concentration product is even approximately constant, only when the square—not when the first power—of the concentration of the univalent ion is employed. This has been shown by experiments with lead iodide in the presence of potassium iodide, with lead chloride in that of other chlorides and with calcium hydroxide in that of ammonium chloride.

I will close by calling your attention to a remarkable principle in regard to the properties of salt solutions, of a character quite distinct from those thus far considered. That many properties of dilute salt solutions can be expressed as the sum of values assigned once for all to the constituent radicals or ions was long ago recognized, and has often been cited as a corollary from the ionic theory. That this additivity of properties persists up to fairly high concentrations is a fact, however, that has received scant consideration, owing to its apparent lack of relationship to that theory. This fact is shown strikingly in the case of certain highly specific optical properties which are ordinarily found to be dependent in a high degree on molecular structure. Thus, the experimental data fully warrant the statement of the principle that *the optical activity and the color of salts in solution, when referred to equivalent quantities, are independent of the concentration and therefore of the degree of ionization of the salts and are additive with respect to the properties of the constituent ions even up to concentrations where a large proportion of the salt is in the un-ionized state.* Abundant data might be cited in support of this principle, especially with reference to optical activity. But I can only illustrate the character of the evidence by presenting a few of the results obtained by Walden with the salts of α-brom camphor sulphonic acid. In 1/30 normal solution he found the following values of the molal rotary power:

Lithium salt	275
Sodium salt	272
Potassium salt	273
Thallium salt	273
Acid itself	273
Beryllium salt	274
Zinc salt	272
Barium salt	272

The values are seen to be substantially identical, although the conductivity shows the acid to have an un-ionized fraction of 7 per cent., the salts of the univalent metals one of 16 per cent., and those of the bivalent metals one of 30 per cent., and although the un-ionized molecules present contain in some cases the elements hydrogen, lithium and beryllium of very small atomic weights, and in two others the elements thallium and barium of large atomic weights.

If there were not other evidence to the contrary, the existence of this general principle, which is also applicable to many other properties, would almost warrant the conclusion that the salts are completely ionized up to the concentration in question, and that the decrease in conductivity is due merely to a change in migration velocity. But, in view of the apparently conclusive evidence against such a hypothesis, we can only conclude that the form of union represented by the un-ionized molecules of salts differs essentially from ordinary chemical combination, it being so much less intimate that the ions still exhibit their characteristic properties, in so far as these are not dependent upon their existence as separate aggregates.

These then are the empirical principles to which a critical analysis of the experimental data leads. Upon these principles must be based the rational, theoretical explanation of the phenomena in question. The discovery of that explanation constitutes one of the most important of the present problems of physical chemistry.

ARTHUR A. NOYES.

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*THE FIELD OF LOGIC.**

CURRENT tendencies in logical theory make a determination of the field of logic fundamental to any statement of the general problems of the science. In view of this fact, I propose in this paper to attempt such a determination by a general discussion of the relation of logic to mathematics, psychology and biology, especially noting in connection with biology the tendency known as pragmatism. In conclusion, I shall indicate what the resulting general problems appear to be.

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I.

There may appear, at first, little to distinguish mathematics in its most abstract, formal and symbolic type from logic. Indeed, mathematics as the universal method of all knowledge has been the ideal of many philosophers, and its right to be such has been claimed of late with renewed force. The recent notable advances in the science have done much to make this claim plausible. A logician, a non-mathematical one, might be tempted to say, that in so far as mathematics is the method of thought in general, it has ceased to be mathematics; but, I suppose, one ought not to quarrel too much with a definition, but should let mathematics mean knowledge simply, if the mathematicians wish it. I shall not, therefore, enter the controversy regarding the proper limits of mathematical inquiry. I wish to note, however, a tendency in the identification of logic and mathematics which seems to me to be inconsistent with the real significance of knowledge. I refer to the exaltation of the freedom of thought in the construction of conceptions, definitions and hypotheses.

The assertion that mathematics is a 'pure' science is often taken to mean that it is in no way dependent on experience in the construction of its basal concepts. The space with which geometry deals may be Euclidean or not, as we please; it may be the real space of experience or not; the properties of it and the conclusions reached about it may hold in the real world or they may not; for the mind is free to construct its conception and definition of space in accordance with its own aims. Whether geometry is to be ultimately a science of this type must be left, I suppose, for the mathematicians to decide. A logician may suggest, however, that the propriety of calling all these conceptions 'space' is not as clear as it ought to be. Still further, there

seems to underlie all arbitrary spaces, as their foundation, a good deal of the solid material of empirical knowledge, gained by human beings through contact with an environing world, the environing character of which seems to be quite independent of the freedom of their thought. However that may be, it is evident, I think, that the generalization of the principle involved in this idea of the freedom of thought in framing its conception of space, would, if extended to logic, give us a science of knowledge which would have no necessary relation to the real things of experience, although these are the things with which all concrete knowledge is most evidently concerned. It would inform us about the conclusions which necessarily follow from accepted conceptions, but it could not inform us in any way about the real truth of these conclusions. It would, thus, always leave a gap between our knowledge and its objects which logic itself would be quite impotent to close. Truth would thus become an entirely extra-logical matter. So far as the science of knowledge is concerned, it would be an accident if knowledge fitted the world to which it refers. Such a conception of the science of knowledge is not the property of a few mathematicians exclusively, although they have, perhaps, done more than others to give it its present revived vitality. It is the classic doctrine that logic is the science of thought as thought, meaning thereby thought in independence of any specific object whatever.

In regard to this doctrine, I would not even admit that such a science of knowledge is possible. You can not, by a process of generalization or free construction, rid thought of connection with objects; and there is no such thing as a general content or as content-in-general. Generalization simply reduces the richness of content and, consequently, of implication. It deals with concrete subject-matter as much and as directly as if the content were individual and specialized. 'Things equal to the same thing are equal to each other,' is a truth, not about thought, but about things. The conclusions about a fourth dimension follow, not from the fact that we have thought of one, but from the conception about it which we have framed. Neither generalization nor free construction can reveal the operations of thought in transcendental independence.

It may be urged, however, that nothing of this sort was ever claimed. The bondage of thought to content must be admitted, but generalization and free construction, just because they give us the power to vary conditions as we please, give us thinking in a relative independence of content, and thus show us how thought operates irrespective of, although not independent of, its content. The binomial theorem operates irrespective of the values substituted for its symbols. But I can find no gain in this restatement of the position. It is true, in a sense, that we may determine the way thought operates irrespective of any specific content by the processes of generalization and free construction; but it is important to know in what sense. Can we claim that such irrespective operation means that we have discovered certain logical constants, which now stand out as the distinctive tools of thought? Or does it rather mean that this process of varying the content of thought as we please reveals certain real constants, certain ultimate characters of reality, which no amount of generalization or free construction can possibly alter? The second alternative seems to me to be the correct one. Whether it is or not may be left here undecided. What I wish to emphasize, is the fact that the decision is one of the things of vital interest for logic, and properly belongs in that science. Clearly, we can never know

the significance of ultimate constants for our thinking until we know what their real character is. To determine that character we must most certainly pass out of the realm of generalization and free construction; logic must become other than simply mathematical or symbolic.

There is another sense in which the determination of the operations of thought irrespective of its specific content is interpreted in connection with the exaltation of generalization and free construction. Knowledge, it is said, is solely a matter of implication, and logic, therefore, is the science of implication simply. If this is so, it would appear possible to develop the whole doctrine of implication by the use of symbols, and thus free the doctrine from dependence on the question as to how far these symbols were themselves related to the real things of the world. If, for instance, *a* implies *b*, then, if *a* is true, *b* is true, and this quite irrespective of the real truth of *a* or *b*. It is to be urged, however, in opposition to this view, that knowledge is concerned ultimately only with the real truth of *a* and *b*, and that the implication is of no significance whatever apart from this truth. There is no virtue in the mere implication. Still further, the supposition that there can be a doctrine of implication simply, seems to be based on a misconception. For even so-called formal implication gets its significance only on the supposed truth of the terms with which it deals. We suppose that *a does* imply *b*, and that *a is* true. In other words, we can state this law of implication only as we first have valid instances of it given in specific, concrete cases. The law is a generalization and nothing more. The formal statement gives only an apparent freedom from experience. Moreover, there is no reason for saying that *a* implies *b* unless it does so either really or by supposition. If *a* really implies *b*, then the implication is clearly not a matter of thinking it; and to suppose the implication is to feign a reality, the implications of which are equally free from the processes by which they are thought. Ultimately, therefore, logic must take account of real implications. We can not avoid this through the use of a symbolism which virtually implies them. Implication can have a logical character only because it has first a metaphysical one.

The supposition underlying the conception of logic I have been examining is, itself, open to doubt and seriously questioned. That supposition was the so-called freedom of thought. The argument has already shown that there is certainly a very definite limit to this freedom, even when logic is conceived in a very abstract and formal way. The processes of knowledge are bound up with their contents, and have their character largely determined thereby. When, moreover, we view knowledge in its genesis, when we take into consideration the contributions which psychology and biology have made to our general view of what knowledge is, we seem forced to conclude that the conceptions which we frame are very far from being our own free creations. They have, on the contrary, been laboriously worked out through the same processes of successful adaptation which have resulted in other products. Knowledge has grown up in connection with the unfolding processes of reality, and has, by no means, freely played over its surface. That is why even the most abstract of all mathematics is yet grounded in the evolution of human experience.

In the remaining parts of this paper, I shall discuss further the claims of psychology and biology. The conclusion I would draw here is, that the field of logic can not be restricted to a realm where the operations of thought are supposed to move freely, independent or irrespective of their contents and the objects of a real world;

and that mathematics, instead of giving us any support for the supposition that it can, carries us, by the processes of symbolization and formal implication to recognize that logic must ultimately find its field where implications are real, independent of the processes by which they are thought, and irrespective of the conceptions we choose to frame.

II.

The processes involved in the acquisition and systematization of knowledge may, undoubtedly, be regarded as mental processes and fall thus within the province of psychology. It may be claimed, therefore, that every logical process is also a psychological one. The important question is, however, is it nothing more? Do its logical and psychological characters simply coincide? Or, to put the question in still another form, as a psychological process simply, does it also serve as a logical one? The answers to these questions can be determined only by first noting what psychology can say about it as a mental process.

In the first place, psychology can analyze it, and so determine its elements and their connections. It can thus distinguish it from all other mental processes by pointing out its unique elements or their unique and characteristic connection. No one will deny that a judgment is different from an emotion, or that an act of reasoning is different from a volition; and no one will claim that these differences are entirely beyond the psychologist's power to ascertain accurately and precisely. Still further, it appears possible for him to determine with the same accuracy and precision, the distinction in content and connection between processes which are true and those which are false. For, as mental processes, it is natural to suppose that they contain distinct differences of character which are ascertainable. The states of mind called belief, certainty, conviction, correctness, truth are, thus, doubtless all distinguishable as mental states. It may be admitted, therefore, that there can be a thoroughgoing psychology of logical processes.

Yet it is quite evident to me that the characterization of a mental process as logical is not a psychological characterization. In fact, I think it may be claimed that the characterization of any mental process in a specific way, say as an emotion, is extra-psychological. Judgments and inferences are, in short, not judgments and inferences because they admit of psychological analysis and explanation, any more than space is space because the perception of it can be worked out by genetic psychology. In other words, knowledge is first *knowledge* and only later a set of processes for psychological analysis. That is why, as it seems to me, all psychological logics, from Locke to our own day, have signally failed in dealing with the problem of knowledge. The attempt to construct knowledge out of mental states, the relations between ideas, and the relation of ideas to things, has been, as I read the history, decidedly without profit. Confusion and divergent opinion have resulted instead of agreement and confidence. On precisely the same psychological foundation, we have such divergent views of knowledge as idealism, phenomenalism and agnosticism with many other strange mixtures of logic, psychology and metaphysics. The lesson of these perplexing theories seems to be that logic, as logic, must be divorced from psychology.

It is also of importance to note, in this connection, that the determination of a process as mental and as thus falling within the domain of psychology strictly, has by no means been worked out to the general satisfaction of psychologists themselves. Recent literature abounds in elaborate discussion of the distinction between what is a mental fact and what not, with a pre-

vailing tendency to draw the remarkable conclusion that all facts are somehow mental or experienced facts. The situation would be worse for psychology than it is, if that vigorous science had not learned from other sciences the valuable knack of isolating concrete problems and attacking them directly, without the burden of previous logical or metaphysical speculation. Thus knowledge, which is the peculiar province of logic, is increased, while we wait for the acceptable definition of a mental fact. But definitions, be it remembered, are themselves logical matters. Indeed, some psychologists have gone so far as to claim that the distinction of a fact as mental is a purely 'logical' distinction. This is significant as indicating that the time has not yet come for the identification of logic and psychology.

In refreshingly sharp contrast to the vagueness and uncertainty which beset the definition of a mental fact, are the palpable concreteness and definiteness of knowledge itself. Every science, even history and philosophy, are instances of it. What constitutes a knowledge ought to be as definite and precise a question as could be asked. That logic has made no more progress than it has in the answer to it, appears to be due to the fact that it has not sufficiently grasped the significance of its own simplicity. Knowledge has been the important business of thinking man, and he ought to be able to tell what he does in order to know, as readily as he tells what he does in order to build a house. And that is why the Aristotelian logic has held its own so long. In that logic, 'the master of them that know' simply rehearsed the way he had systematized his own stores of knowledge. Naturally we, so far as we have followed his methods, have had practically nothing to add. In our efforts to improve on him, we have too often left the right way and followed the impossible method inaugurated by Locke. Had we examined with greater persistence our own methods of making science, we should have profited more. The introduction of psychology, instead of helping the situation, only confuses it.

Let it be granted, however, in spite of the vagueness of what is meant by a mental fact, that logical processes are also mental processes. This fact has, as I have already suggested, an important bearing on their genesis, and sets very definite limits to the freedom of thought in creating. It is not, however, as mental processes that they have the value of knowledge. A mental process which is knowledge purports to be connected with something other than itself, something which may not be a mental process at all. This connection should be investigated, but the investigation of it belongs, not to psychology, but to logic.

I am well aware that this conclusion runs counter to some metaphysical doctrines, and especially to idealism in all its forms, with the epistemologies based thereon. It is, of course, impossible here to defend my position by an elaborate analysis of these metaphysical systems. But I will say this. I am in entire agreement with idealism in its claim that questions of knowledge and of the nature of reality can not ultimately be separated, because we can know reality only *as* we know it. But the general question as to how we know reality can still be raised. By this I do not mean the question, how is it possible for us to have knowledge at all, or how it is possible for reality to be known at all, but how, as a matter of fact, we actually do know it? That we really do know it, I would most emphatically claim. Still further, I would claim that what we know about it is determined, not by the fact that we can know in general, but by the way reality, as distinct from our knowledge, has determined. These ways appear to me to be ascertainable, and form, thus, undoubtedly a section

of metaphysics. But the metaphysics will naturally be realistic rather than idealistic.

III.

Just as logical processes may be regarded as, at the same time, psychological processes, so they may be regarded, with equal right, as vital processes, coming thus under the categories of evolution. The tendency so to regard them is very marked at the present day, especially in France and in this country. In France, the movement has, perhaps received the clearer definition. In America the union of logic and biology is complicated—and at times even lost sight of—by emphasis on the idea of evolution generally. It is not my intention to trace the history of this movement, but I should like to call attention to its historic motive in order to get it in a clear light.

That the theory of evolution, even Darwinism itself, has radically transformed our historical, scientific and philosophical methods, is quite evident. Add to this the influence of the Hegelian philosophy, with its own doctrine of development, and one finds the causes of the rather striking unanimity which is discoverable in many ways between Hegelian idealists, on the one hand, and philosophers of evolution of Spencer's type, on the other. Although two men would, perhaps, not appear more radically different at first sight than Hegel and Spencer, I am inclined to believe that we shall come to recognize more and more in them an identity of philosophical conception. The pragmatism of the day is a striking confirmation of this opinion, for it is often the expression of Hegelian ideas in Darwinian and Spencerian terminology. The claims of idealism and of evolutionary science and philosophy have thus sought reconciliation. Logic has been, naturally, the last of the sciences to yield to evolutionary and genetic treatment. It could not escape long, especially when the idea of evolution had been so successful in its handling of ethics. If morality can be brought under the categories of evolution, why not thinking also? In answer to that question we have the theory that thinking is an adaptation, judgment is instrumental. But I would not leave the impression that this is true of pragmatism alone or that it has been developed only through pragmatic tendencies. It is naturally the result also of the extension of biological philosophy. In the biological conception of logic, we have, then, an interesting coincidence in the results of tendencies differing widely in their genesis.

It would be hazardous to deny, without any qualifications, the importance of genetic considerations. Indeed, the fact that evolution in the hands of a thinker like Huxley, for instance, should make consciousness and thinking apparently useless epiphenomena in a developing world, has seemed like a most contradictory evolutionary philosophy. It was difficult to make consciousness a real function in development so long as it was regarded as only cognitive in character. Evolutionary philosophy, coupled with physics, had built up a sort of closed system with which consciousness could not interfere, but which it could know, and know with all the assurance of a traditional logic. If, however, we were to be consistent evolutionists, we could not abide by such a remarkable result. The whole process of thinking must be brought within evolution, so that knowledge, even the knowledge of the evolutionary hypothesis itself, must appear as an instance of adaptation. In order to do this, however, consciousness must not be conceived as only cognitive. Judgment, the core of logical processes, must be regarded as an instrument and as a mode of adaptation.

The desire for completeness and consistency in an evolutionary philosophy is not the only thing which makes the denial

of genetic considerations hazardous. Strictly biological considerations furnish reasons of equal weight for caution. For instance, one will hardly deny that the whole sensory apparatus is a striking instance of adaptation. Our perceptions of the world would thus appear to be determined by this adaptation, to be instances of adjustment. They might conceivably have been different, and in the case of many other creatures, the perceptions of the world are undoubtedly different. All our logical processes, referring ultimately as they do to our perceptions, would thus appear finally to depend on the adaptation exhibited in the development of our sensory apparatus. So-called laws of thought would seem to be but abstract statements or formulations of the results of this adjustment. It would be absurd to suppose that a man thinks in a sense radically different from that in which he digests, or a flower blossoms, or that two and two are four in a sense radically different from that in which a flower has a given number of petals. Thinking, like digesting and blossoming, is an effect, a product, possibly a structure.

I am not at all interested in denying the force of these considerations. They have, to my mind, the greatest importance, and due weight has, as yet, not been given to them. To one at all committed to a unitary and evolutionary view of the world, it must indeed seem strange if thinking itself should not be the result of evolution, or that, in thinking, parts of the world had not become adjusted in a new way. But while I am ready to admit this, I am by no means ready to admit some of the conclusions for logic and metaphysics which are often drawn from the admission. Just because thought, as a product of evolution, is functional and judgment instrumental, it by no means follows that logic is but a branch of biology, or that knowledge of the world is but a temporary adjustment, which, as knowledge, might have been radically different. In these conclusions, often drawn with Protagorean assurance, two considerations of crucial importance seem to be overlooked, first, that adaptation is itself metaphysical in character, and secondly, that while knowledge may be functional and judgment instrumental, the character of the functioning has the character of knowledge, which sets it off sharply from all other functions.

It seems strange to me that the admission that knowledge is a matter of adaptation and thus a relative matter, should, in these days, be regarded as in any way destroying the claims of knowledge to metaphysical certainty. Yet, somehow, the opinion widely prevails that the doctrine of relativity necessarily involves the surrender of anything like absolute truth. 'All our knowledge is relative, and, therefore, only partial, incomplete, and but practically trustworthy,' is a statement repeatedly made. The fact that, if our development had been different, our knowledge would have been different, is taken to involve the conclusion, that our knowledge can not possibly disclose the real constitution of things, that it is essentially conditional, that it is only a mental device for getting results, that any other system of knowledge which would get results equally well would be equally true; in short, that there can be no such thing as metaphysical or epistemological truth. These conclusions do indeed seem strange, and especially strange on the basis of evolution. For while the evolutionary process might, conceivably, have been different, its results are, in any case, the results of the process. They are not arbitrary. We might have digested without stomachs, but the fact that we use stomachs in this important process ought not to free us from metaphysical respect for the organ. As M. Rey suggests, in the *Revue philosophique* for June, 1904, a creature without the sense

of smell would have no geometry, but that does not make geometry essentially hypothetical, a mere mental construction; for *we* have geometry because of the working out of nature's laws. Indeed, instead of issuing in a relativistic metaphysics of knowledge, the doctrine of relativity should issue in the recognition of the finality of knowledge in every case of ascertainably complete adaptation. In other words, adaptation is itself metaphysical in character. Adjustment is always adjustment between things, and yields only what it does yield. The things or elements get into the state which is their adjustment, and this adjustment purports to be their actual and unequivocal ordering in relation to one another. Different conditions might have produced a different ordering, but, again, this ordering would be equally actual and unequivocal, equally the *one* ordering to issue from them. To suppose or admit that the course of events might have been and might be different, is not at all to suppose or admit that it was or is different; it is, rather, to suppose and admit that we have real knowledge of what that course really was and is. This seems to be very obvious.

Yet the evolutionist often thinks that he is not a metaphysician, even when he brings all his conceptions systematically under the conception of evolution. This must be due to some temporary lack of clearness. If evolution is not a metaphysical doctrine when extended to apply to all science, all morality, all logic, in short, all things, then it is quite meaningless for evolutionists to pronounce a metaphysical sentence on logical processes. But if evolution is a metaphysics, then its sentence is metaphysical, and in every case of adjustment or adaptation we have a revelation of the nature of reality in a definite and unequivocal form. This conclusion applies to logical processes as well as to others. The recognition that they are vital processes can, therefore, have little significance for these processes in their distinctive character as logical. They are like all other vital processes in that they are vital and subject to evolution. They are unlike all others in that thought is unlike digestion or breathing. To regard logical processes as vital processes does not in any way, therefore, invalidate them as logical processes or make it superfluous to consider their claim to give us real knowledge of a real world. Indeed, it makes such a consideration more necessary and important.

A second consideration overlooked by the Protagorean tendencies of the day is, that judgment, even if it is instrumental, purports to give us knowledge, that is, it claims to reveal what is independent of the judging process. Perhaps I ought not to say that this consideration is overlooked, but rather that it is denied significance. It is even denied to be essential to judgment. It is claimed that, instead of revealing anything independent of the judging process, judgment is just the adjustment and no more. It is a reorganization of experience, an attempt at control. All this looks to me like a misstatement of the facts. Judgment *claims* to be no such thing. It does not function as such a thing. When I make any judgment, even the simplest, I may make it as the result of tension, because of a demand for reorganization, in order to secure control of experience; but the judgment *means* for me something quite different. It means decidedly and unequivocally that in reality, apart from the judging process, things exist and operate just as the judgment declares. If it is claimed that this meaning is illusory, I eagerly desire to know on what solid ground its illusoriness can be established. When the conclusion was reached, that gravitation varies directly as the mass and inversely as the square of the distance, it was doubtless reached in an evolutionary and prag-

matic way; but it claimed to disclose a fact which prevailed before the conclusion was reached, and in spite of the conclusion. Knowledge has been born of the travail of living, but it has been born as knowledge.

When the knowledge character of judgment is insisted on, it seems almost incredible that anyone would think of denying or overlooking it. Indeed, current discussions are far from clear on the subject. Pragmatists are constantly denying that they hold the conclusions that their critics almost unanimously draw. There is, therefore, a good deal of confusion of thought yet to be dispelled. Yet there seems to be current a pronounced determination to banish the epistemological problem from logic. This is, to my mind, suspicious, even when epistemology is defined in a way which most epistemologists would not approve. It is suspicious just because we must always ask eventually that most epistemological and metaphysical question: 'Is knowledge true?' To answer, it is true when it functions in a way to satisfy the needs which generated its activity, is, no doubt, correct, but it is by no means adequate. The same answer can be made to the inquiry after the efficiency of any vital process whatever, and is, therefore, not distinctive. We have still to inquire into the specific character of the needs which originate judgments and of the consequent satisfaction. Just here is where the uniqueness of the logical problem is disclosed. With conscious beings, the success of the things they do has become increasingly dependent on their ability to discover what takes place in independence of the knowing process. That is the need which generates judgment. The satisfaction is, of course, the attainment of the discovery. Now to make the judgment itself and not the consequent action the instrumental factor, seems to me to misstate the facts of the case. Nothing is clearer than that there is no necessity for knowledge to issue in adjustment. And it is clear to me, that increased control of experience, while resulting from knowledge, does not give to it its character. Omniscience could idly view the transformations of reality and yet remain omniscient. Knowledge works, but it is not, therefore, knowledge.

These considerations have peculiar force when applied to that branch of knowledge which is knowledge itself. Is the biological account of knowledge correct? That question we must evidently ask, especially when we are urged to accept the account. Can we, to put the question in its most general form, accept as an adequate account of the logical process a theory which is bound up with some other specific department of human knowledge? It seems to me that we cannot. Here we must be epistemologists and metaphysicians, or give up the problem entirely. This by no means involves the attempt to conceive pure thought set over against pure reality—the kind of epistemology and metaphysics justly ridiculed by the pragmatist—for knowledge, as already stated, is given to us in concrete instances. How knowledge in general is possible, is, therefore, as useless and meaningless a question as how reality in general is possible. The knowledge is given as a fact of life, and what we have to determine is not its non-logical antecedents or its practical consequences, but its constitution as knowledge and its validity. It may be admitted that the question of validity is settled pragmatically. No knowledge is true unless it yields results which can be verified, unless it *can* issue in increased control of experience. But I insist again, that that fact is not sufficient for an account of what knowledge claims to be. It claims to issue in control because it is true in independence of the control. And it is just this assurance that is needed to distinguish knowledge from what is not knowledge. It is the ne-

cessity of exhibiting this assurance which makes it impossible to subordinate logical problems, and forces us at last to questions of epistemology and metaphysics.

As I am interested here primarily in determining the field of logic, it is somewhat outside my province to consider the details of logical theory. Yet the point just raised is of so much importance in connection with the main question, that I venture the following general considerations. This is, perhaps, the more necessary because the pragmatic doctrine finds in the concession made regarding the test of validity one of its strongest defences.

Of course a judgment is not true simply because it is a judgment. It may be false. The only way to settle its validity is to discover whether experience actually provides what the judgment promises, that is, whether the conclusions drawn from it really enable us to control experience. No mere speculation will yield the desired result, no matter with how much formal validity the conclusions may be drawn. That merely formal validity is not the essential thing, I have pointed out in discussing the relation of logic to mathematics. The test of truth is pragmatic. It is apparent, therefore, that the formal validity does not determine the actual validity. What is this but the statement that the process of judgment is not itself the determining factor in its real validity? It is, in short, only valid judgments that can really give us control of experience. The implications taken up in the judgment must, therefore, be real implications which, as such, have nothing to do with the judging process, and which, most certainly, are not brought about by it. And what is this but the claim that judgment as such is never instrumental? In other words, a judgment which affected its own content would only by the merest accident function as valid knowledge. We have valid knowledge, then, only when the implications of the judgment are found to be independent of the judging process. We have knowledge only at the risk of error. The pragmatic test of validity, instead of proving the instrumental character of judgment, would thus appear to prove just the reverse.

Valid knowledge has, therefore, for its content a system of real, not judged or hypothetical implications. The central problem of logic which results from this fact is not how a knowledge of real implications is then possible, but what are the ascertainable types of real implications. But, it may be urged, we need some criterion to determine what a real implication is. I venture to reply that we need none, if by such is meant anything else than the facts with which we are dealing. I need no other criterion than the circle to determine whether its diameters are really equal. And, in general, I need no other criterion than the facts dealt with to determine whether they really imply what I judge them to imply. Logic appears to me to be really as simple as this. Yet there can be profound problems involved in the working out of this simple procedure. There is the problem already stated of the most general types of real implication, or, in other words, the time honored doctrine of categories. Whether there are categories or basal types of existence, seems to me to be ascertainable. When ascertained, it is also possible to discover the types of inference or implication which they afford. This is by no means the whole of logic, but it appears to me to be its central problem.

These considerations will, I hope, throw light on the statement, that while knowledge works, it is not therefore knowledge. It works because its content existed before its discovery by the knowledge process, and because its content was not effected or brought about by that process. Judgment was the instrument of its discovery, not the instru-

ment which fashioned it. While, therefore, willing to admit that logical processes are vital processes, I am not willing to admit that the problem of logic is radically changed thereby in its formulation or solution, for the vital processes in question have the unique character of knowledge, the content of which is what it claims to be, a system of real implications which existed prior to its discovery.

In the psychological and biological tendencies in logic, there is, however, I think, a distinct gain for logical theory. The insistence that logical processes are both mental and vital has done much to take them out of the transcendental aloofness from reality in which they have often been placed, especially since Kant. So long as thought and object were so separated that they could never be brought together, and so long as logical processes were conceived wholly in terms of ideas set over against objects, there was no hope of escape from the realm of pure hypothesis and conjecture. Locke's axiom that 'the mind, in all its thoughts and reasonings, hath no other immediate object but its own ideas,' an axiom which Kant did so much to sanctify, and which has been the basal principle of the greater part of modern logic and metaphysics, is most certainly subversive of logical theory. The transition from ideas to anything else is rendered impossible by it. Now it is just this axiom which the biological tendencies in logic have done so much to destroy. They have insisted, with the greatest right, that logical processes are not set over against their content as idea against object, as appearance against reality, but are processes of reality itself. Just as reality can and does function in a physical or a physiological way, so also it functions in a logical way. The state we call knowledge becomes, thus, as much a part of the system of things as the state we call chemical combination. The problem how thought can know anything becomes, therefore, as irrelevant as the problem how elements can combine at all. The recognition of this is a great gain, and the promise of it most fruitful for both logic and metaphysics.

But, as I have tried to point out, all this surrendering of pure thought as opposed to pure reality, does not at all necessitate our regarding judgment as a process which makes reality different from what it was before. Of course there is one difference, namely, the logical one; for reality prior to logical processes is unknown. As a result of these processes it becomes known. These processes are, therefore, responsible for a known as distinct from an unknown reality. But what is the transformation which reality undergoes in becoming known? When it becomes known that water seeks its own level, what change has taken place in the water? It would appear that we must answer, none. The water which seeks its own level has not been transformed into ideas or even into a human experience. It appears to remain, as water, precisely what it was before. The transformation which takes place, takes place in the one who knows, a transformation from ignorance to knowledge. Psychology and biology can afford us the natural history of this transformation, but they can not inform us in the least as to why it should have its specific character. That is given and not deduced. The attempts to deduce it have, without exception, been futile. That is why we are forced to take it as ultimate in the same way we take as ultimate the specific character of any definite transformation. To my mind, there is needed a fuller and more cordial recognition of this fact. The conditions under which we, as individuals, know, are certainly discoverable, just as much as the conditions under which we breathe or digest. And what happens to

things when we know them, is also as discoverable as what happens to them when we breathe them or digest them.

But here the idealist may interpose that we can never know what happens to things when we know them, because we can never know them before they become known. I suppose I ought to wrestle with this objection. It is an obvious one, but, to my mind, it is without force. The objection, if pursued, can carry us only in a circle. The problem of knowledge is still on our hands, and every logician of whatever school, the offerer of this objection also, has, nevertheless, attempted to show what the transformation is that thought works, for all admit that it works some. Are we, therefore, engaged in a hopeless task? Or have we failed to grasp the significance of our problem? I think the latter. We fail to recognize that, in one way or other, we do solve the problem, and that our attempts to solve it show quite clearly that the objection under consideration is without force. Take for instance, any concrete case of knowledge, the water seeking its own level, again. Follow the process of knowledge to the fullest extent, we never find a single problem which is not solvable by reference to the concrete things with which we are dealing, nor a single solution which is not forced upon us by these things rather than by the fact that we deal with them. The transformation wrought is thus discovered, in the progress of knowledge itself, to be wrought solely in the inquiring individual, and wrought by repeated contact with the things with which he deals. In other words, all knowledge discloses the fact that its content is not created by itself, but by the things with which it is concerned.

It is quite possible, therefore, that knowledge should be what we call transcendent and yet not involve us in a transcendental logic. That we should be able to know without altering the things we know, is no more and no less remarkable and mysterious than that we should be able to digest by altering the things we digest. In other words, the fact that digestion alters the things is no reason that knowledge should alter them, even if we admit that logical processes are vital and subject to evolution. Indeed, if evolution teaches us anything on this point, it is that knowledge processes are real just as they exist, as real as growth and digestion, and must have their character described in accordance with what they are. The recognition that knowledge can be transcendent and yet its processes vital, seems to throw light on the difficulty evolution has encountered in accounting for consciousness and knowledge. All the reactions of the individual seem to be expressible in terms of chemistry and physics without calling in consciousness as an operating factor. What is this but the recognition of its transcendence, especially when the conditions of conscious activity are quite likely expressible in chemical and physical terms? While, therefore, biological considerations result in the great gain of giving concrete reality to the processes of knowledge, the gain is lost, if knowledge itself is denied the transcendence which it so evidently discloses.

IV.

The argument advanced in this discussion has had the aim of emphasizing the fact, that in knowledge we have actually given, as content, reality as it is in independence of the act of knowing, that the real world is self-existent, independent of the judgments we make about it. This fact has been emphasized in order to confine the field of logic to the field of knowledge as thus understood. In the course of the argument, I have occasionally indicated what some of the resulting problems of

logic are. These I wish now to state in a somewhat more systematic way.

The basal problem of logic becomes, undoubtedly, the metaphysics of knowledge, the determination of the nature of knowledge and its relation to reality. It is quite evident that this is just the problem which the current tendencies criticized have sought, not to solve, but to avoid or set aside. Their motives for so doing have been mainly the difficulties which have arisen from the Kantian philosophy in its development into transcendentalism, and the desire to extend the category of evolution to embrace the whole of reality, knowledge included. I confess to feeling the force of these motives as strongly as any advocate of the criticized opinions. But I do not see my way clear to satisfying them by denying or explaining away the evident character of knowledge itself. It appears far better to admit that a metaphysics of knowledge is as yet hopeless, rather than so to transform knowledge as to get rid of the problem; for we must ultimately ask after the truth of the transformation. But I am far from believing that a metaphysics of knowledge is hopeless. The biological tendencies themselves seem to furnish us with much material for at least the beginnings of one. Reality known is to be set over against reality unknown or independent of knowledge, not as image to original, idea to thing, phenomena to noumena, appearance to reality; but reality as known is a new stage in the development of reality itself. It is not an external mind which knows reality by means of its own ideas, but reality itself becomes known through its own expanding and readjusting processes. So far I am in entire agreement with the tendencies I have criticised. But what change is effected by this expansion and readjustment? I can find no other answer than this simple one: the change to knowledge. And by this I mean to assert unequivocally that the addition of knowledge to a reality hitherto without it, is simply an addition to it and not a transformation of it. Such a view may appear to make knowledge a wholly useless addition, but I see no inherent necessity in such a conclusion. Nor do I see any inherent necessity of supposing that knowledge must be a useful addition. Yet I would not be so foolish as to deny the usefulness of knowledge. We have, of course, the most palpable evidences of its use. As we examine them, I think we find, without exception, that knowledge is useful just in proportion as we find that reality is not transformed by being known. If it really were transformed in that process, could anything else than confusion result from the multitude of knowing individuals?

To me, therefore, the metaphysics of the situation resolves itself into the realistic position, that a developing reality develops, under ascertainable conditions, into a known reality without undergoing any other transformation, and that this new stage marks an advance in the efficiency of reality in its adaptations. My confidence steadily grows that this whole process can be scientifically worked out. It is impossible here to justify my confidence in detail, and I must leave the matter with the following suggestion. The point from which knowledge starts and to which it ultimately returns, is always some portion of reality where there is consciousness, the things, namely, which, we are wont to say, are in consciousness. These things are not ideas representing other things outside of consciousness, but real things, which, by being in consciousness, have the capacity of representing *each other*, of standing for or implying each other. Knowledge is not the creation of these implications, but their successful systematization. It will be found, I think, that this general statement

is true of every concrete case of knowledge which we possess. Its detailed working out would be a metaphysics of knowledge, an epistemology.

Since knowledge is the successful systematization of the implications which are disclosed in things by virtue of consciousness, a second logical problem of fundamental importance is the determination of the most general types of implication with the categories which underlie them. The execution of this problem would naturally involve, as subsidiary, the greater part of formal and symbolic logic. Indeed, vital doctrines of the syllogism, of definition, of formal inference, of the calculus of classes and propositions, of the logic of relations, appear to be bound up ultimately with a doctrine of categories; for it is only a recognition of basal types of existence with their implications, that can save these doctrines from mere formalism. These types of existence or categories are not to be regarded as free creations or as the contributions of the mind to experience. There is no 'deduction' of them possible. They must be discovered in the actual progress of knowledge itself, and I see no reason to suppose that their number is necessarily fixed, or that we should necessarily be in possession of all of them. It is requisite, however, that in every case categories should be incapable of reduction to each other.

A doctrine of categories seems to me to be of the greatest importance in the systematization of knowledge, for no problem of relation is even statable correctly, before the type of existence to which its terms belong has been first determined. I submit one illustration to reinforce this general statement, namely, the relation of mind to body. If mind and body belong to the same type of existence, we have one set of problems on our hands, but if they do not, we have an entirely different set. Yet volumes of discussion written on this subject have abounded in confusion, simply because they have regarded mind and body as belonging to radically different types of existence and yet related in terms of the type to which one of them belongs. The doctrine of 'parallelism' is, perhaps, the epitome of this confusion.

The doctrine of categories will involve not only the greater part of formal and symbolic logic, but will undoubtedly carry the logician into the doctrine of method. Here it is to be hoped that recent tendencies will result in effectively breaking down the artificial distinctions which have prevailed between deduction and induction. Differences in method do not result from differences in points of departure, or between the universal and the particular, but from the categories, again, which give the method direction and aim, and result in different types of synthesis. In this direction, the logician may hope for an approximately correct classification of the various departments of knowledge. Such a classification is, perhaps, the ideal of logical theory.

Frederick J. E. Woodbridge.
Columbia University.

CLARENCE L. HERRICK.

The death of Professor Clarence L. Herrick September 15 in New Mexico was noted in Science for September 23. In him neurology and geology alike have lost a brilliant investigator and a teacher of rare power.

His scientific work began in the high school. During his college course at the University of Minnesota, where he graduated in 1880, he was employed on the Natural History Survey of the state and for five years following he was actively connected with this work, completing a large quarto on the Mammals of Minnesota in 1885. From 1884 to 1889 and again from

1892 to 1894 he held a professorship at Denison University. Here he continued his zoological studies, but in connection with his class work became interested in the Waverly limestones and shales of Ohio. He devoted himself to the study of these for several years with characteristic intensity, publishing most of his results and those of his students in the *Bulletin of the Scientific Laboratories of Denison University*, which he founded in 1885. From the first his teaching was extraordinarily successful, particularly in kindling enthusiasm and love of research. This was due partly to his attractive personality, partly to his fearless originality, but chiefly to his philosophic insight and his ability to open up his deepest thinking even to elementary pupils. And so a very large proportion of his students have themselves achieved success as original workers in science.

During his last ten years, spent in New Mexico on account of the breakdown in health which forced him to leave Ohio, he resumed his geological studies, publishing several important articles on the geology of that territory.

From 1889 to 1891 he was professor of zoology in the University of Cincinnati. Here his geological labors were interrupted and he entered with great energy into a series of neurological investigations which he had long before planned to undertake. He founded the *Journal of Comparative Neurology and Psychology*, which (now under the editorship of his brother, C. Judson Herrick) has made a permanent and important place for itself. Beginning his neurological work upon the brain of rodents, he accumulated a large mass of data which he found almost incapable of correlation. Believing that the key could be found only in lower primitive types he began to examine a large number of such in a very thorough manner. His results were published rapidly and with little attempt at correlation. These papers were illustrated by large numbers of beautiful plates which his rapid and skillful use of the pencil made possible. His plan was to secure a large amount of accurate data while his eyesight was still perfect, and later review the whole field of vertebrate neurology, using his own observations as a nucleus around which to build a unified system by further research at critical points. In 1892, after some months of study abroad, he returned to Denison and continued his neurological work with great energy, until in December 1893 failing health compelled him to go to New Mexico. He soon recovered sufficiently to resume work, but local conditions were such that his attention was again directed mainly to geological problems. The work of correlating his neurological studies was left somewhat incomplete, but it is probable that this may be accomplished through the labors of his brain-children.

For four years he did a useful work as president of the University of New Mexico, here as everywhere stimulating young men to undertake research by the influence of his own example. In these later years we see the successful struggle of a noble soul dominated by a great purpose over the discouragements of physical weakness and suffering.

A. D. COLE.

SCIENTIFIC BOOKS.

The Harriman Alaska Expedition. Vols. VIII. and IX., Insects. New York, Doubleday, Page & Co. 1904.

Volumes VIII. and IX. of the Harriman Alaska Expedition, published in cooperation with the Washington Academy of Sciences and dealing with the subject of insects, have just been issued, and represent the most notable contribution to the literature of entomology of the year, and will rank among the most important of the American contributions to this subject. The material discussed in these two volumes was substantially all of it col-

lected by the Entomologist of the Expedition, Professor Trevor Kincaid, of the chair of biology in the University of the State of Washington. Professor Kincaid is known as an expert student and collector of insects, and his work on this expedition demonstrates his ability in this field. More than 8,000 insects were collected, representing a thousand and one species, 344 of which are new to science, and including at least half a dozen new genera. Upon the return of the expedition the collections were carefully labeled and sorted into groups by Professor Kincaid and transmitted to Dr. L. O. Howard, chief of the Bureau of Entomology, U. S. Department of Agriculture, and honorary curator of insects in the National Museum, for distribution to specialists for study and report. The results are given in eighteen important papers. In most instances these contributions deal only with the material collected in Alaska by Professor Kincaid. In the Myriapoda, however, all the available data relating to northwestern North America is brought together, this paper, therefore, representing the present knowledge in this group for the region designated. In some other cases, as in the Hymenoptera, the previously known records from Alaska are added. A number of the papers were published in the 'Proceedings of the Washington Academy of Sciences,' but are here reprinted from the same electrotype plates, an explanatory page accompanying each of these last mentioned papers.

Insects.	Described Species.	New Species.	Total.
Apterygota	8	6	14
Neuropteroids	25	9	34
Odonata	8	0	8
Orthoptera	1	0	1
Hemiptera { Heteroptera	18	0	18
Hemiptera { Homoptera	14	10	24
Coleoptera	154	1	155
Diptera	213	63	276
Lepidoptera	66	9	75
Hymenoptera	98	237	335
Myriapoda	6	3	9
Arachnida	46	6	52
Total	657	344	1,001

The results of this expedition are indicated in the table given above, in which are listed the previously described, the new species and the total number of species collected, arranged by orders.

The itinerary of the trip given in the introduction is very interesting reading. It describes the localities visited from day to day, indicating the predominating vegetation and the more important insects found, and is a most valuable supplement to the more technical succeeding papers.

The original idea was to publish a single volume of insects, but when the papers were assembled it was found necessary to publish the insect portion in two volumes. The largest number of species were found in the orders Diptera and Hymenoptera, and the two more important papers are those dealing especially with these two groups, namely, the paper on Diptera, by Mr. Coquillett, and on Hymenoptera, by Mr. Ashmead, the former considering 276 species, and the latter 335 species. Mr. Ashmead has included in his paper all the known Hymenoptera previously reported from Alaska, and also certain unstudied Alaskan material represented in the National Museum collections. The extent of the additions in this order will be understood from the statement that previous to the publication of this paper but 30 species of Hymenoptera were known from Alaska. Two hundred and one of the 335 species listed by Mr. Ashmead are described as new.

A complete list of the subjects and authors follows: 'Introduction,' by Trevor Kincaid; 'Arachnida,' by Nathan Banks; 'Myriapoda,' by O. F. Cook; 'Apterygota,' by Justus Watson Folsom; 'Orthoptera,' by A. N. Caudell; 'Aphididæ,' by Theo. Pergande; 'Homoptera,' by William H. Ashmead; 'Heteroptera,' by O. Heidemann; 'Odonata,' by Rolla P. Currie; 'Neuropteroid Insects,' by Nathan Banks; 'Coleoptera,' by E. A. Schwarz; 'Metamorphoses of Alaska Coleoptera,' by Trevor Kincaid; 'Lepidoptera,' by Harrison G. Dyar; 'Diptera,' by D. W. Coquillett; 'Tenthredinoidea,' by Trevor Kincaid; 'Sphegoidea and Vespoidea,' by Trevor Kincaid; 'Formicidæ,' by Theo. Pergande; 'Hymenoptera,' by William H. Ashmead.

Each volume is separately indexed, and

many of the papers are illustrated with lithographic plates. All have appropriate head figures, and there are occasional text figures. Part I., Vol. VIII., has a handsome colored plate in which representative insects of different orders are figured, and Part II., Vol. IX., has, as a frontispiece, a heliotype print of Popof Island. The style of printing, binding and illustration is a testimony to the experience and interest of the editor, Dr. C. Hart Merriam, and of the publishers, Doubleday, Page & Co.

C. L. MARLATT.
U. S. DEPARTMENT OF AGRICULTURE.

Lehrbuch der vergleichenden Anatomie. By B. HALLER. Zweite Lieferung. Jena, Gustav Fischer. 1904.

A little more than a year ago a review of the first part of Haller's 'Lehrbuch der vergleichenden Anatomie' was published in this journal (SCIENCE, September 13, 1903) and we have now before us the second part, dealing with the chordata, a volume of some 579 large octavo pages and containing 465 figures.

As is but natural, the standpoint of the author is that of the Heidelberg school and his treatment of the subject is essentially the same as that presented by Gegenbaur in his 'Vergleichenden Anatomie der Wirbelthiere,' so much so, indeed, that the present volume may be regarded as very largely an abridgment of the more extensive work. As such it will undoubtedly prove useful, especially as the author's style is generally clear, the reading pleasant and the figures numerous, excellently reproduced and pertinent.

To speak of the volume as an efficient abridgment of Gegenbaur's 'Vergleichenden Anatomie' is no inconsiderable praise, but it also implies that a perusal of the book gives one the impression that little has been added to our knowledge of the comparative anatomy of the vertebrates since Gegenbaur's volumes appeared. It is unfortunate, also, that the author has chosen to express dogmatically certain hypotheses which, to say the least, are still *sub judice*. Thus, for example, the dogmatic reference (p. 465) of all cases of polymastia in the human species of atavism is certainly ill-advised, as is also the apparently unconditional acceptance of the explanation of the double articulations of the ribs as a relic of a primary double-ribbed condition, a theory which lacks at present any embryological confirmation. So too the emphasized homology (p. 512) of the præchordal portion of the head with the præoral lobe of annelids is decidedly open to adverse criticism and places the author, it may be noted, on a very different standpoint from that adopted by Gegenbaur, for whom the præchordal portion of the cranium was a secondary structure developed from the primitive chordal cranium in adaptation to the development of the brain and sense-organs.

An efficient treatment of the vertebrate nervous system is to be expected from Professor Haller, and in some respects, notably in that some attention is paid to the tracts of the central system, the section shows an improvement over what is usually furnished by text-books of the grade of the present one. A little too much is attempted, unfortunately, within the limits set for the section, the result being an occasional obscurity, but a far more serious defect is the failure to discuss the cranial nerves on the basis of their components. Nothing that has been added to our knowledge of the nervous system within recent years equals in morphological significance the recognition of the cranial nerve components, and any discussion of the cranial nerves on the basis of the old two-root hypothesis must be futile so far as a proper understanding of their general morphology is concerned. And yet not a word is to be found in the volume under review concerning nerve components, but merely one of the variants of the oft-repeated two-root theory, which for many years has but served to retard progress towards the solution of the problem of vertebrate cephalogenesis.

More excusable is the insufficient treatment afforded the sympathetic system, for in it the author is but following the examples of his predecessors, no adequate account of that physiologically important system being as yet incorporated in any text-book of vertebrate anatomy. But scant consideration is given

to the thyreoid and thymus glands, and the difficult morphology of the cœlom and peritoneum is dismissed with little more than a page and a half of actual reading matter.

In the review of the first part of the 'Lehrbuch' attention was called to the exceptionally numerous and gross typographical errors it contained. Two pages of errata contained in the first part form an introduction to the second part, and aroused hopes that due care had been taken that the latter should be tolerably free from errors of this sort. The hopes, however, were vain. Although the errors are less numerous and striking than in the earlier part yet they are sufficiently abundant to cause surprise. They are, as before, most frequent in connection with the proper names, but one must needs rub one's eyes and look again when one reads of the lamina scribosa of the ethmoid or of the hetopapancreas. J. P. McM.

SOCIETIES AND ACADEMIES.

THE SAN FRANCISCO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY.

The sixth regular meeting of the San Francisco Section of the American Mathematical Society was held at the Universty of California on October 1, 1904. Fifteen members of the society were present. A number of other teachers of mathematics living in or near San Francisco attended both of the sessions. The following officers were elected for the ensuing year:

Chairman—Professor Haskell.

Secretary—Professor Miller.

Program Committee—Professors Haskell, Lehmer and Miller.

Major P. A. MacMahon member of the council of the London Mathematical Society, presided during the morning session, and Professor Irving Stringham during the afternoon session. The following papers were read:

Professor E. J. Wilczynski: 'General projective theory of space curves.'

Professor L. M. Hoskins: 'Stresses in an elastic sphere due to a superficial layer of heavy matter of uniform thickness bounded by a circle.'

Dr. T. M. Putnam: 'Concerning the factors of $(p^2-1)^2$ that are of the form $px+1$, and allied problems.'

Major P. A. MacMahon: 'Groups of linear differential operators.'

Professor H. F. Blichfeldt: 'On primitive continuous groups.'

Professor D. N. Lehmer: 'Figures invariant in space of three dimensions under the most general projective transformation.'

Professor G. A. Miller: 'Determination of all the groups of order 2^m which contain an odd number of cyclic subgroups of composite order.'

The program provided also for a 'Conference on recent investigations in the foundations of geometry.' This conference was opened by Professor Stringham, who was followed by Dr. J. H. McDonald. A number of the high school teachers took part in the discussion, which had reference mainly to the influence of the recent investigations on the teaching of elementary mathematics. The next meeting will be held at Stanford University, on February 25, 1905.

G. A. Miller,
Secretary of the Section.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

The section met at the American Museum of Natural History on October 17, 1904, at 8:15 P.M., with Professor James F. Kemp in the chair.

The special business of the evening was the nomination by the section of officers to serve for the calendar year 1905. The following nominations were made: For chairman and vice-president of the academy, E. O. Hovey, of the American Museum of Natural History; for secretary, A. W. Grabau, of Columbia University.

The program of the evening consisted of a lecture by E. O. Hovey, on 'St. Vincent, British West Indies: The Eruptions of 1902 and their Immediate Results.'

The author gave a summary account of the results obtained on two expeditions undertaken by him for the American Museum of Natural History in 1902 and 1903, for the study of the volcanic eruptions of the Soufrière which began in May, 1902. Particular attention was devoted to the heavy coating of

volcanic ash deposited upon the northern portion of the island of St. Vincent and the ash-filling of the gorges of the Wallibou and Rabaka Dry Rivers, the devastation wrought in the forests and on the plantations within a radius of about five miles from the crater and the phenomena of primary eruptions observed in the crater and of secondary eruptions observed in the Wallibou and Rabaka ash-beds. The nature of the exploding eruption cloud was discussed and it was shown how the heavily dust-laden steam cloud kept close to the surface of the ground under the influence of gravity while its initial velocity was furnished by the horizontal component of the explosion.

About eighty lantern slides were used in illustrating the speaker's remarks.

EDMUND OTIS HOVEY,
Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA.

THE 155th meeting was held in the Chemical Lecture Room, Tuesday, October 11, 7:30 P.M. The following papers were given: 'The Construction of a Double Six,' by Professor Archibald Henderson; 'The Geological History of Currituck Banks,' by Professor Collier Cobb.

ALVIN S. WHEELER,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

SOIL MANAGEMENT.*

"The three papers here printed have been refused departmental publication by the Chief of the Bureau of Soils."

In glancing at this note on the title page of this pamphlet of 168 pages, the reader is naturally struck with the query, why the U. S. Department of Agriculture should decline to publish the results of the work of such a man as King, working under its auspices. Has the salt indeed lost its savor? Both American and European scientists have been accustomed for many years to regard with confidence and respect the work and publications of the man upon whom, by common consent, the mantle of Wollny has fallen since the premature death of the soil physicist of Germany. It is certainly worth the while of every worker in agricultural science to see and judge for himself whether a star has been eclipsed or blotted out from the scientific firmament, and if so, from what cause.

We are, at the outset, somewhat reassured as to the totality of the conjectured eclipse, by finding that the three rejected bulletins are but a portion of a series of six forming the report of King, as head of the Division of Soil Management, for the years 1902 and 1903. Since three out of the six have been accepted by the department for publication, it is evident that King's right hand has not wholly lost its cunning during these two years. What, then, is the matter with Bulletins D, E and F, here presented to us by the author at his personal expense and risk, and as he expressly states, in their original form?

As it happens, the rest of the series, bulletins B, C and G, have not yet reached publication by the bureau of soils. We must, therefore, rely upon the intrinsic evidence contained in the three now before us, to settle the reason for their rejection.

In his preface the author reticently says that the 'adequate discussion was withheld in order to avoid, as far as possible, antagonizing the published views of the Bureau' (of Soils); and hence the three papers are published without general comments. It is to the conclusions deducible from the facts given, then, that we must look for the substance of these papers, and for the possible cause of their falling under condemnation.

Bulletin E, the first in the pamphlet and the most important of the three, treats of the results obtained in the fertilization with stable manure, in different multiple proportions, of eight different types of soils. The experiments were conducted on eight two-acre plots, located respectively near Goldsboro, N. C., Upper Marlboro, Md., Lancaster, Pa., and Janesville, Wis., and representing two groups

* 'Investigations in Soil Management,' being three of six papers on the influence of soil management upon the water-soluble salts in soils, and the yield crops, by F. H. King, Madison, Wisconsin. Published by the author, with permission of the Secretary of Agriculture.

of four each, 'strongly contrasted in their native productive capacities, in order that strongly marked differences might be dealt with.' The dressings of barnyard manure used were at the rate of five, ten and fifteen tons per acre. The crops grown were potatoes and corn, with a series of unmanured check-plots between, in each case.

The crops from each series of plots were weighed, mostly both in the green and in the dry condition; and concurrently, the kinds and amounts of soluble salts extractable by water from the soils of each of the plots before and at different intervals after the application of the manure, were determined according to the delicate methods used in the investigations of aqueous soil extracts.* Moreover, the amounts of the several substances contained in the soil extracts, present in the sap of the plants themselves, were likewise determined, in order to ascertain the relations between the soil solutions and the substances taken up by the crops.

It is not easy for the outsider to detect anything reprehensible in this well-considered plan of operations. It seems to be admirably conceived for the determination of the relation of the soil solutions to plant nutrition and crop production under normal, practical conditions. The details given regarding the actual carrying out of the experiments are equally unexceptionable, except as concerns some points in respect to which, apparently, there was interference of some sort with the plan; *e. g.*, in the matter of making chemical analyses of the stable manure used at the several localities. But however regrettable, this and some other omissions, apparently imposed by superior authority, do not vitiate, to any material extent, the conclusions arrived at by King.

The plan and methods of experimentation being thus unexceptionable so far as any one examining the record given can judge, the only question remaining is whether the conclusions deduced from the experimental results are justified, and whether these are in conflict with practical or scientific experience, or with common sense. Of these conclusions it will be best to give the chief ones in the words of the author.

After giving, on page 5, a table showing the percentage relations of crop yield under different fertilizations, he says: 'It will be seen that in the case of the poorer soils there is a percentage difference of 46 between the yields of the fifteen-ton subplots and those to which nothing has been added; but a difference of only eighteen on the stronger soils.' Recalculating these results on the next page so as to show their relations more clearly, he adds: 'These results show that both relatively and absolutely, adding fertilizers to the poorer soils has had a greater effect than the same treatment with stronger soils.' Farther on, after giving a table of the several yields of water-free shelled corn, he says: "It is here seen that on the four poorer soils, there is a systematic difference in the yield of water-free shelled corn, closely related to the fertilizers applied to the soil. The group of four stronger soils do not show, throughout, this systematic relation." Photographic views of the corn on the growing plots show these differences clearly in the growth of the plants.

The only criticism that could be, perhaps, made of the work leading to these conclusions from an outside point of view, is that they are so clearly and thoroughly in accord with all former experience, both practical and experimental, that they are largely foreseen.

Then follows the record and discussion of corresponding experiments with potatoes, which yield practically the same results and conclusions.

Then are given the results of analyses of leachings of the same soils upon which these crops had been grown. The results are presented in a table, from which "it is very clear that the effect of different amounts of stable manure applied to these soils * * * has been such upon the recovery of the water-soluble salts as to enable the same treatment to remove different amounts from different fertilizations. * * * There is a clear quantitative relation, too, between the yields and the salts recovered, these (the former) increasing where the essential ingredients of plant food are higher."

* Bulletin No. 22, Bureau of Soils.

King also details the experiments made with small (four-pound) samples of soils mixed with much larger amounts of the same manure, the leachings of which after 65 days, gave, in general, results corresponding to those obtained from the field tests; and he discusses in detail the apparent effects upon the solubilities of the several ingredients of plant food, and the influence upon the formation and reduction of nitrates; showing that there is no direct ratio between the amount of manure added and the nitrates found in the different soils. He determines and discusses, likewise, the relation of the salts added to the soils in the manure to those recovered by leaching, all vouched for by full analytical data.

Finally, King shows the effects upon the plants of different doses of manure, with respect to the water-soluble salts recoverable from the plants themselves. In both cases the influence of manuring is mainly seen to be a direct one, as has, in fact, already been shown by Godlewski. "It is thus shown that the crops on the manured ground have recovered 29 per cent. more potash from the four stronger soils, and 40 per cent. more from the poorer soils, where the fifteen tons of manure had been applied." Lime and magnesia, on the contrary, were diminished where the potash was increased.

What may be considered the final summing-up of this bulletin is given by King in the following paragraph on page 60, the last but one:

> The observations here presented, both upon the soils and upon the plants which had grown upon them make it clear that when farmyard manure is applied to fields it has the effect not only of increasing the yields, but at the same time of increasing the amounts of water-soluble salts which can be recovered from the soils themselves and from the plants which have grown upon them.

I have thought it necessary to present to the readers of SCIENCE somewhat in detail the contents of this bulletin E, in order to show what kind of work it is to which the bureau of soils refuses its *imprimatur*. To the unofficial mind—the *beschränkte Unterthanenverstand*—it appears as an admirable piece of work, in a line but little touched by agricultural investigators thus far, and manifestly likely to lead to important new lights, as well as to definite quantitative corroboration of old ones. As to bulletins D and F, respectively, on 'The Absorption of Water-soluble Salts by Different Soil Types' and on 'The Movement of Water-soluble Salts in Soils,' they are in a measure complementary to bulletin E, affording most interesting side-lights upon the general subject of the latter; they are altogether of similar high scientific grade. They also figure among the 'rejected papers.'

The clew to that rejection evidently lies in 'the published views of the Bureau of Soils,' which King for the time being does not desire to antagonize by discussion, as stated in the preface. What those views are is not specified; but it is easy to see that the results of King's work are wholly incompatible with the remarkable utterances of 'Bulletin 22,' now well known to all interested in agricultural science. Essentially, that bulletin promulgates the doctrine that while fertilizers 'do sometimes, and even frequently,' seem to increase production, yet since, according to data given therein, the aqueous soil solution is always of the same composition in all soils, it follows that all soils contain sufficient available plant food to maintain productiveness indefinitely; and that the moisture supply is the one controlling condition, climate permitting.

Such being the official, orthodox doctrine, it becomes clear why especially bulletin 'E,' showing pointedly the very reverse of the official doctrine to be true, could not receive the official approval and *imprimatur*. And that a man of King's standing and reputation could not, under such circumstances, do otherwise than tender his resignation, to take effect after his report had been completed and submitted, is obvious. This having been done, the Bureau of Soils is now rid of a contumacious, insubordinate person, who refuses to subscribe to his chief's scientific dicta as set forth in Bulletin 22; which, it is well known, has not received the assent of a single scientist of weight, and has been controverted and repudiated both in America and Europe by all who have taken any notice of it.

But worse than the ill-founded hypotheses of the head of one of the most important bureaus of the Department of Agriculture, which, moreover, receives and spends one of the largest appropriations in the budget of that department, is the return to medievalism indicated in the case before us. It is not only that of a deliberate attempt to suppress the truth, but it indicates on the part of the morally responsible head of that bureau a more than child-like confidence in the permanent success of the obscurantist régime such as is practiced and defended by Pobyedonostseff. Yet it is doubtful that even the latter, or the puissant head of the Russian Empire himself, would undertake to pass the censor's black brush over inductive scientific papers like these of King.

It is impossible to conceive that in the twentieth century, and especially in a country claiming to be progressive *par excellence*, such a régime should be allowed to continue for any length of time. King has uttered his '*e pur si muove*' by the publication of his rejected papers; it now behooves the scientific men of the country to voice their emphatic protest against the dictation of official orthodox science of any kind, from headquarters at Washington.

E. W. Hilgard.

Berkeley, Calif.,
September 29, 1904.

'THE METRIC FALLACY,' ONCE MORE.

To the Editor of Science: It is not uncommon for professors of linguistic science to be asked the question, 'What do you think will be the common language of the civilized world when the different peoples adopt one?' Despite the impossibility of direct knowledge on such a subject, conjecture is easy. Probably the most plausible of such conjectures is that the Teutonic and Romance languages will continue the present process of intermingling indefinitely until a common language becomes the result, difference of language diminishing into mere difference of dialect. It may be fair to assume that the English language, now the one most widely in use, will be the most important of the different components of the future language of civilization, though we have to admit the possibility that the Anglo-Saxon may give place within a few centuries to some progressive competitor, such as the Japanese. Supposing an international language thus to become developed by common consent due to common interests, international business both political and commercial will be facilitated. But even approximate uniformity of thought, of custom, of interest, has never yet received practical demonstration as a human possibility. If the future should develop a single universal language, it must be universal only in the sense of being a recognized standard from which many local offshoots will grow. No other view seems consistent with the continued existence of a reasonable degree of personal liberty.

Now, assume that a similar question is asked about the future coinage, weights and measures of the civilized world. The present chaos is bad enough, but far from being so bad as it was a century ago. The tendency has been unmistakably toward unification, but with the goal still far away. Any one who imagines that either the metric system or the British system, as formulated to-day, will meet all the requirements of both science and commerce a century or two hence, may be happy in his optimism, but he can not be credited with much appreciation of what experience has hitherto shown to be the processes of natural evolution.

In a recent communication (Science, September 16, p. 373) Mr. F. A. Halsey, writing in response to my criticisms of the attack upon the advocates of the metric system by Messrs. Halsey and Dale, says, "My purpose in writing this letter is to point out that Professor Stevens's admissions are of far greater importance than he seems to suspect." He considers me to have 'admitted pretty much all' that the antimetric contestants have contended for; but he admits that two important differences still exist. One is that I regard the change to the metric system as worth the cost, while he and Mr. Dale think it is not. The other is that I regard the change feasible, while he and Mr. Dale think it impossible. These two statements certainly indicate a considerable gulf between us, whatever may have

been the admissions made with a view to impartiality. The gulf seems incapable of being bridged by any structure built on the foundations set forth in Mr. Halsey's book. His self-complacent conclusion is, perhaps, the outcome of the fact that he is an avowed special advocate representing pecuniary interests that would suffer by the change considered, and that an advocate must claim everything in sight. His attitude can not possibly be judicial unless some miracle should suddenly bring about such a change of heart as to evoke words of penitence for his lack of appreciation of metric righteousness and of horror at his own British sinfulness.

What has been written by me about the metric system sets forth my own views alone. It was not intended to be representative of any other person or any pecuniary interests. It was an attempt to be fair, and as nearly as possible non-partisan, however cordial would be my welcome to the exclusive adoption of the metric system everywhere, if such were possible. There are doubtless many other metric advocates who do not share some of my views, and for whose opinions I entertain the highest respect. We may differ regarding the ease with which the change can be introduced, or as to the number of years of grace that should be allowed between initial and final legal enactments. The fact that my estimate regarding the limits of this period greatly exceeds that of some distinguished men does not in the least justify Mr. Halsey's assumption that I regard their view as 'worthless,' however limited may be the value of his own conclusion that the British inch is immovable, even 'until doomsday'—an infinity of years of grace. If my estimates are too liberal no one can hail the demonstration of such a mistake with more pleasure than myself.

My admission that among the uneducated on the continent of Europe the use of non-metric names and units is still common does not invalidate the claim of the metric advocates that the use of the metric system has become fairly well established among a majority of the educated classes in the same countries. Metric advocates who claim more than this are probably exceptional. They certainly would not reverse their opinions because the peasantry are now, have always been and can always be expected to be extremely conservative. Mr. Halsey devotes four fifths of the space in his book to a demonstration of the persistence of old units everywhere in spite of legislation. No such demonstration would be necessary for any reader who has paid reasonable attention to history, or who has had the opportunity to observe the uneducated in our own country. He gives a list, nine pages in length, of 'non-metric units used in metric countries,' with their American equivalents. M. Guillaume, of the International Bureau of Measures, has recently shown (*Physical Review*, September, 1904, pp. 234–237) that much of this table is worthless, not only containing information that is false, but quoting as non-metric the local names of units which are in value identical with metric units. Out of nearly five hundred entries in this table it is safe to say that a majority are local and almost unknown to international commerce. This grand parade of misinformation is sufficiently in accord with Mr. Halsey's assertion, 'We have the simplest and the most uniform system of weights and measures of any country in the world.'

It is quite possible for metric advocates to recognize the force of conservatism and vested interests, and yet to have faith in the future approach toward international unification of weights and measures. Even if this should be accomplished by legislation and sustained by public demand in all the great commercial centers of the world, the peasantry can be depended upon to hold on to their local inherited units and to furnish the data for such a table as Mr. Halsey has collected with so much care.

Mr. Halsey is disappointed that no special notice was taken of two chapters which he regarded the best in his book. He endeavors to make a sharp line of division between scientific men and manufacturers. Of the former he says: "They are measures, not makers, and their opinions have no value and no application as related to manufacturing." This estimate likewise is not surprising in view of

the elastic use of the word 'scientific' among the populace. The expression of contempt just quoted manifests a very limited horizon, and the 'measurers' are probably able to avoid intrusion. But the day for such sharp distinctions is past. Everything depends upon what we mean by 'scientific.' A man may devote years to chemistry, or physics, or biology, without learning scientific method, by making himself a measurer and resting satisfied with such routine. Mr. Halsey does not seem to remember that discovery is an aim in the pursuit of science, or that the demonstration of originality is incomparably more important in determining scientific standing than the ability to measure, however important this may be as a means. The mental training understood to be 'scientific' has to be applied in every pursuit where close observation, orderly arrangement, accurate calculation, independent thought, patient industry and good judgment are necessary. The recent presiding officer of the society representing English and American chemical industries, which convened a few weeks ago in New York, has a world-wide reputation as a scientific man rather than as a measurer. His successor as president is an American manufacturer, but one whose exceptional mastery of scientific method has enabled him to achieve distinction as a 'maker' of chemicals. According to Mr. Halsey's classification the opinions of Sir William Ramsay should be of no importance to Mr. Nichols; and if one of them is a metric advocate the other should be anti-metric. Our distinguished English guest has had many pleasant things to express about America, but in regard to our manufacturers he felt constrained to say: "The majority of them do not make it a practice to read scientific journals or to familiarize themselves with the latest trend of scientific thought. English manufacturers are far ahead of Americans in this respect, and Germany shows a clean pair of heels to both." What would he have said after reading Mr. Halsey's extraordinary views?

Any citizen of our country, who has an interest in educational, scientific or commercial progress has a right to an opinion, and to make himself heard if he can, regarding our weights and measures. To say that it is 'an industrial and commercial, and not a scientific question' is mere assumption. Some scientific manufacturers have expressed themselves in favor of the metric system. Mr. Halsey's claim, that scientific men who urge a change that may affect the immediate interests of manufacturers 'simply meddle with other people's affairs,' is as untenable as the claim of a politician who argues that no American has a right to urge tariff changes because they damage the interests of the trusts.

That the pecuniary interests to be affected by a change in our system of weights and measures are large and important is readily conceded. No one, moreover, will deny the great advantage of standardization for screw threads, pipes and textiles, or that a change of standards would be expensive. Mr. Halsey says that manufacturers know this to be 'impossible.' This is not conceded, either by metric advocates or by all manufacturers. In some departments of industry metric standardization has become established in Europe; and if for the same industry a metric standard is in use in one country and a British standard in another the abandonment of one of these will at last be necessary, even if it involves 'meddling with other people's affairs.' The two chapters of Mr. Halsey's book which he regards as the most important thus fail to establish anything more than what was already apprehended, that 'certain people would lose money and otherwise suffer much inconvenience by the change.' His assumption of 'impossibility' is entirely in keeping with the lack of 'scientific' or judicial fairness in the rest of his book.

The universal and exclusive employment of the metric system, if at all within the bounds of possibility, is so remote that it needs no consideration. What we do need, and what seems quite possible at no very distant day, is an international system of weights and measures, adopted by the central governments of the civilized world for use in all international commerce and in all government work. This would not compel American or English manufacturers to change their standards for

most of their customers, but it would put them to some extra expense and inconvenience if government purchases are made in the best market. Whether this international system should be exclusively metric is a matter of policy requiring careful consideration. The yard may be lengthened to equality with the meter, or the meter may be lengthened to forty inches, or many British units may be discarded and some metric units may be substituted for them, while some British units are retained. In any case the change, whatever it be, must tend toward unification and simplicity. It must necessarily cause initial increase of confusion, which will pass away without unreasonable delay in great commercial centers. Outside of such centers the people may be expected to hold on to their old habits; and in the remote rural districts hundreds of years may be insufficient to bring about uniformity. The essential desideratum is definiteness in value and simplicity in mutual relation among the units adopted. The mere nomenclature is of subordinate importance. Old names will certainly be retained by the masses even if values are modified, just as a dozen different values existed a few years ago for what was called foot, fuss, pied, etc. The change in values will be much easier for the masses if the old names are retained by legal provision; but this is a matter for which there is plenty of time. The Archimedean lever is indeed unknown, but even the English inch has been 'moved' in the past and Mr. Halsey's 'impossibilities' are no greater than what have been gradually overcome in the past and what may be gradually overcome in the future.

W. LE CONTE STEVENS.
WASHINGTON AND LEE UNIVERSITY,
October 3, 1904.

PROFESSOR WILLIAM MORTON WHEELER ON THE KELEP.

IN SCIENCE of September 30 (p. 437) Professor William Morton Wheeler has discussed the introduction into the United States of the kelep or Guatemalan cotton-protecting ant, and has reached decidedly adverse conclusions. Every new proposition must, of course, run the gauntlet of criticism, scientific and unscientific. Professor Wheeler claims special 'liberty to comment' because of 'exceptional opportunities,' but he nevertheless disregards several facts which might have mitigated the confidence of the prophecy.

It becomes apparent that the Poneridæ with which he is acquainted must be very different from the kelep. After observing colonies of *Ectatomma* and *Odontomachus,* both in nature and in captivity, I am ready to follow Mayr and Ashmead in assigning these genera to separate families, as unlike, indeed, as rats and rabbits. Whatever may be true of other Poneridæ or Odontomachidæ, it seems that the species of *Ectatomma* are widely distributed, enterprising ants. The kelep, instead of being a rare 'archaic' curiosity, is decidedly the dominant and most abundant insect of the Guatemalan cotton fields. The colonies, too, are several times as large as supposed by Professor Wheeler. They contain, usually, between 200 and 300 individuals, instead of from 40 to 50. There are seldom less than 100, and sometimes 400 or more.

The adaptability of the kelep is further shown by its association with the cotton for the sake of its nectar, as well as by its skill in stinging the boll-weevil. It is true, as Professor Wheeler says, that there are other pugnacious ants which 'attack' boll-weevils (or, for that matter, anything else which comes in their way), but they let them go again, and have no standing as 'destroyers.' To sting, disable, carry off, dismember and consume the pest, is still the unique distinction of the kelep.

Like some editors of newspapers Professor Wheeler will not be satisfied with the ants unless they absolutely exterminate the weevils, 'chase them into the Gulf of Mexico,' etc. The planters would probably be grateful, however for an addition of even ten per cent. to their crop—which illustrates the difference of standpoints. That the keleps make a regular practise of killing weevils renders them of distinct agricultural interest; the question is no longer whether they are useful, but whether we can get enough of them. Just how effi-

cient they might be made, even in Guatemala, is still unknown, for there the tree cottons are perennial sources of infestation, and all the climatic and cultural conditions favor the weevils. In Texas where the winter season will greatly assist in reducing the numbers of the beetles the utility of the ants may be correspondingly accentuated.

Of course it was highly improbable from *a priori* considerations that such an ant should be found, colonized in Texas, and made of practical use to the cotton industry. The chances are still very much against it, no doubt. It was obvious to Professor Wheeler from the first that the case was hopeless, but his warning has come too late, like the doctor whose patient had recovered. Plenty of difficulties remain, but the *post facto* prognosis is already in need of revision. The kelep is not being studied for the sake of results of 'negative, scientific value,' whatever that may mean, but because it appeared to the authorities of the Department of Agriculture that in so serious a difficulty every clue should be followed to some concrete conclusion. Unless the insurmountable obstacles can be pointed out more definitely it may be necessary to continue to seek them on experimental lines.

O. F. Cook.

Victoria, Texas,
October 4, 1904.

SPECIAL ARTICLES.

THE BRAIN OF A SWEDISH STATESMAN.

Retzius, in Vol. XI. of his extensive 'Biologische Untersuchungen,' presents a morphological study of the brain of a noted Swedish statesman. This is the fourth of a series of brains of eminent persons to be described by this investigator, the other three being those of the astronomer Gyldén, the mathematician Kovalevski, and the physicist and pedagog Siljeström. Retzius, in view of the rather negative results of older investigators in the field of cerebral morphology, and with the wish of satisfying himself whether the brains of persons of superior intellectual capacity were or were not to be distinguished from ordinary brains by special anatomical characters proposed, some time ago in conjunction with the physiologist Tigerstedt, that his colleagues in Stockholm bequeath their brains for scientific purposes. The forms of bequests received the signatures of just two men; viz., Retzius and Tigerstedt. Better results had been obtained by the Société mutuelle d'Autopsie (founded 1881) which now possesses ten brains or more, among them those of Gambetta, Bertillon, Vèron and G. de Mortillet. The Cornell Brain Association, founded by Professor Wilder in 1889, has bequeathed to it seventy brains of orderly educated persons, of which thirteen are already preserved in the Neurological Laboratory at Cornell. The American Anthropometric Society, formed in Philadelphia in 1890 possesses six brains of eminent scholars, and a number of others are promised. But such promises sometimes fail to be fulfilled, as happened in the case of Mrs. Elizabeth Cady Stanton. Her brain-bequest to Cornell, embodied in her will, was not read until after the funeral—designedly, it is stated, for her wishes on this head were well-known—because of the objections of relatives. It is indeed difficult, even under more favorable circumstances, after the death of a person eminent in human affairs to request—and obtain—the permission of the afflicted family for the removal, preservation and study of the brain.

In view of such adverse circumstances, Professor Retzius considers himself fortunate in having obtained, from time to time, the brain of some known person of superior mental power; and though the smallness of number of brains in this collection obviates the formulation of positive conclusions, he still deems it his duty to record descriptions of all brains of notable persons that might become available, before the problem of the interrelation of cerebral surface morphology and the mental aptitudes is entirely abandoned. The value of investigations of this kind has been repeatedly urged by Bischoff, Waldeyer, Manouvrier, Wilder and the writer ('Study of the Brain of the late Major J. W. Powell,' *American Anthropologist*, N. S., Vol. V., No. 4, 1903).

The identity of the Swedish statesman

whose brain Retzius now describes is not revealed in connection with this study, owing to the refusal of the sons of the deceased to accord permission to divulge the name. Retzius had, however, known him well since his youth and presents a few general remarks concerning the subject's intellectual capacity. The man showed great aptitude for learning early in life, was very successful in his studies at school and under the faculty of law. He rapidly advanced to the position of Minister of Finance (age 37) and three years after to that of Prime Minister. He was a provincial governor up to the time of his death at the age of 53. He is described as a highly gifted jurist, statesman, thinker, orator and philanthropist. Of large stature, dolichocephalic and of blond complexion, he belonged to the genuine Swedish type. His brain, removed on the second day after death by Dr. Curt Wallis, weighed 1489 grams. It was preserved in a mixture of 3 per cent. potassium bichromate and 2 per cent. formal, suspended in the fluid by a string tied to the basilar artery. The form of the brain was thus well preserved. As in all of Retzius' memoirs, this study is accompanied by beautifully executed photogravures and contour drawings.

The brain is well formed and richly convoluted. Viewed dorsally its shape is symmetrically ovoid with the greatest width in the subparietal region. The height is rather reduced. The association areas of the frontal and parietal regions exhibit a richness and complexity of fissuration, but there is hardly any noteworthy characteristic or redundancy of development in any particular territory. Nor were such findings to be expected. In life the man showed a well balanced intellect; his aptitudes were good in all directions, not in any special direction alone. Endowed with an excellent memory and good reasoning powers, he showed great skill and clearness of thought in parliamentary debate, without necessarily availing himself of purely rhetorical art. While not naturally devoted to any particular branch of the sciences, creative arts or human action, he could familiarize himself with all of these in the way of facile general understanding. This harmonius construction of the mental abilities is in no small measure correlative with that species of symmetry which this brain exhibited, and which is certainly exceptional in the richly convoluted brains of persons of highly developed but rather one-sided mental superiority. It may be noted, however, that the left subfrontal gyre ('Broca's gyrus,' the motor speech center) is somewhat favored in its development as compared with the same region on the right side.

EDW. ANTHONY SPITZKA.

SCIENTIFIC NOTES AND NEWS.

COLUMBIA UNIVERSITY has been celebrating the hundredth and fiftieth anniversary of its foundation as King's College during the past week. A large reception was given by the trustees on the afternoon of October 28. On the morning of October 31, the cornerstones of the School of Mines building, of a chapel, and of two dormitories were laid, and the physical training building of Teachers College was dedicated; in the afternoon a university convocation was held, and President Butler gave a commemorative address. Honorary degrees were conferred on thirty-three alumni, including Francis Delafield, M.D., 1863, emeritus professor of the practice of medicine in the College of Physicians and Surgeons, Columbia University; Edward Gamaliel Janeway, M.D., 1864, dean of the University and Bellevue Hospital Medical College; William Mecklenburg Polk, M.D., 1869, dean of the Cornell University Medical College; John Green Curtis, M.D., 1870, professor of physiology in Columbia University; William Henry Welch, M.D., 1875, professor of pathology in the Johns Hopkins University; Andrew James McCosh, M.D., 1880, visiting surgeon at the Presbyterian Hospital; Walter Kelnap James, M.D., 1883, professor of the practice of medicine in Columbia University and visiting physician at Roosevelt and Presbyterian Hospitals; William Bleecker Potter, A.B., 1866, E.M., 1869, mining and metallurgical engineer; Henry Smith Munroe, E.M., 1869, Ph.D., 1877, professor of mining in Columbia University; Frederick Remsen Hutton, A.B., 1873, E.M., C.E., 1876, Ph.D.,

1881, professor of mechanical engineering in Columbia University, and dean of the Faculty of Applied Science; William Stewart Halsted, M.D., 1877, professor of surgery in Johns Hopkins University, and surgeon-in-chief at the Johns Hopkins Hospital; Nathaniel Lord Britton, E.M., Ph.D., 1879, emeritus professor of botany in Columbia University, and director of the New York Botanical Garden; Moses Allen Starr, M.D., 1880, professor of neurology in Columbia University, consulting physician at the Presbyterian Hospital; Luther Emmett Holt, M.D., 1880, Carpentier professor of pediatrics in Columbia University, and attending physician at Babies' and New York Foundling Hospitals; Michael Idvorsky Pupin, A.B., 1883, professor of electro-mechanics in Columbia University; George Sumner Huntington, M.D., 1884, professor of anatomy in Columbia University; Ernst Joseph Lederle, Ph.B., 1886, Ph.D., 1895, former commissioner of health of the City of New York.

Dr. Albrecht Penck, professor of physical geography at the University of Vienna, who came to this country to attend the International Geographical Congress and the International Congress of Arts and Science, has been visiting Washington, Baltimore and New York, and is about to give a course of Lowell lectures in Boston.

Dr. L. Manouvrier, director of the anthropological laboratory of the École des Hautes Etudes and professor in the École d'Antropologie de Paris, gave an address before the Anthropology Club of Yale University on October 17.

The Journal of the American Medical Association states that the movement for a memorial to Dr. William Osler is taking the direction of a great medical and library building. It is thought that the collections will be national—possibly international—in extent.

Mr. Frank Springer, of Las Vegas, New Mexico, has been elected a foreign correspondent of the Geological Society of London, in recognition of his work on Crinoids.

Dr. Yersin has resigned the position of director of the Medical School of Hanoi, to become head of the Pasteur Institute of Nha Trang.

The British Secretary of State for the Colonies has authorized the conduct of a mineral survey of Nigeria, under the supervision of Professor Wyndham Dunstan, F.R.S., director of the Imperial Institute.

Nature states that Mr. H. Martin Leake, of Christ's College, Cambridge, has been appointed economic botanist to the government of the United Provinces, India, and proceeds at once to the botanic gardens, Saharanpur, N. W. P.

Dr. E. C. Richardson, of Princeton University, has been elected president of the American Library Association.

The annual address before the Geographical Society of Philadelphia was given on November 2 by the president of the society, Mr. Henry G. Bryant. His subject was 'Mexico and its People.'

Captain Robert F. Scott, of the British National Antarctic Expedition, will address the opening meeting of Royal Geographical Society.

Professor F. H. Getman, of Johns Hopkins University, is giving a course of sixty lectures on physical chemistry at the College of the City of New York.

Sir Charles Bruce made the introductory address at the opening session of the London School of Tropical Medicine on October 7.

Among those who will lecture in the public course at the College of the City of New York are Dr. William H. Maxwell, William Barclay Parsons and Dr. H. W. Wiley.

John Locke was born on August 29, 1632, and died on October 28, 1704. The two hundredth anniversary of his death was commemorated at the Johns Hopkins University on November 1. It was expected that addresses would be made by Principal C. Lloyd Morgan, of Bristol, England; Professor F. J. E. Woodbridge, Columbia University; Dr. William Osler, Johns Hopkins University; Professor J. McB. Sterrett, George Washington University, and Dr. William T. Harris, United States Commissioner of Education.

AT the sixth International Congress of Physiology at Brussels, Professor Heger, the president, inaugurated a movement to erect a monument to Marey, the inventor of the sphygmograph.

THERE will be a civil service examination on November 22 and 23 to fill positions as irrigation engineer and drainage engineer, in connection with the irrigation and drainage investigations in the Office of Experiment Stations, Department of Agriculture. The initial salary will be from $1,500 to $2,000 per annum according to qualifications. On the same days there will be an examination to fill the position of pharmacologist at a salary of $800, and of chemist and collector at a salary of $1,500 in the Bureau of Government Laboratories at Manila. On November 30 there will be an examination to fill the position of scientific assistant in the Bureau of Fisheries at a salary of $750.

THE International Society of the Directors of Museums met at Nuremberg, from October 3 to 5.

THE fifth Italian Pædiatric Congress will be held in Rome on October 28 to 31.

THE Committee on Awards of the Louisiana Purchase Exposition, St. Louis, have conferred upon the Wellcome Chemical Research Laboratories a grand prize and three gold medals, in recognition of the importance and educational value of the chemical and pharmacognostical researches conducted under the direction of Dr. Frederick B. Power.

A PARTY of about 150 French physicians and surgeons have paid a visit to London. They were entertained at the various medical institutions of the city.

AN amendment to the state constitution, which will be voted upon at the next election in November, provides for exempting from taxation the property of the California Academy of Sciences.

THE lectures given by Professor de Vries, at the University of California, during the summer of 1904, are being edited by Dr. D. T. MacDougal and will be published by the Open Court Publishing Co., of Chicago, in January, in a volume entitled 'Species and Varieties; their Origin by Mutation.'

WE learn from *The American Geologist* that the paleontological library of the late Professor Charles E. Beecher, of Yale University, is for sale. It comprises more than 3,000 pamphlets and 200 volumes. Those wishing for further information should apply to Professor Charles Schuchert, Yale University Museum, New Haven, Conn.

Nature states that an attempt is being made to establish an association of teachers of science, art and technology who are engaged in teaching at London institutions. It is hoped that the new association may become ultimately a national body. It has been agreed at meetings already held that the principal aims and objects of the association should be the general advancement of technical education; the interchange of ideas regarding methods of teaching technical subjects; the promotion and safeguarding of the professional interests of the members of the association in such matters as tenure, pensions and registration; to lay the views of the association before educational authorities and before the public; and to enable the members to cooperate as a body with other scientific and educational associations. Arrangements have been made for a general meeting to be held on October 22 at the Birkbeck College, Chancery Lane, at 3:30. All London teachers of science, art and technology, other than those employed in secondary schools, are invited to be present.

WE learn from *The British Medical Journal* that the next congress of French scientific societies will be held at Algiers in 1905. The following are the questions proposed for discussion in the section of medicine: Tuberculosis and the means of diminishing contagion; sanatoriums at high altitudes and by the seaside; hygiene of hot countries; methods of disinfection against contagious diseases and the results obtained in towns, in rural districts and in the institutions where the disinfection of dwellings and living rooms is practised; the conveyance of water to towns; the different forms of plague and its propagation; the part played by insects in the dissemination of disease; the prophylaxis of

malaria in Northern Africa; trypanosomiasis in Algeria.

The Geographical Journal states that a railway is projected from Turin to Martigny. The line would have a total length of 157 kilometers (97½ English miles), with a maximum gradient of one in twenty, while the traction would be electric, power for this purpose being supplied by waterfalls. Breaking off from the line connecting Modane with Turin, the new line would cross the plains of the Canavese to Pont, entering the valley of the Orco, and passing by a tunnel under the Paradis *massif;* then, mounting halfway up the left flank of the Aosta valley, it would pass Morge and Courmayeur, whence, by tunnel under the Col de Ferret, it would run in Swiss territory along the Dranse to Martigny. The new line, it is pointed out, would have the advantage over the Mount Cenis, St. Gothard, and Simplon lines as the shortest route between northwestern Italy and the countries of central Europe.

Los Angeles, Cal., has 3,000 acres of brush land called Griffith Park, which it intends to convert into a commercial forest. This is said to be the first instance of a city in the United States creating a forest. The practise is common in Europe, where the forest-parks have not only contributed to the pleasure of the people, but have been more than self-supporting through their timber output. Under its cooperative offer the Bureau of Forestry had last summer at Los Angeles four of its experts, making a comprehensive planting plan for the forest. This plan was completed at the end of September. The idea is to convert a waste piece of land into a productive forest, which will not only pay for its creation and care through the sale of mature timber, but will be a place of recreation for the citizens of Los Angeles.

UNIVERSITY AND EDUCATIONAL NEWS.

It is said that the Sheffield Scientific School, of Yale University, will receive $238,000 and land of unknown value under the will of the late Levi C. Viets.

Messrs. Palmer and Hornbostel, of New York, have, as the result of a competition, been appointed architects for the Carnegie Technical Schools at Pittsburg. It is said that $5,000,000 will be spent on them.

Ground has been broken for the new physics and biology building at Rochester University, which will cost $150,000.

At the twenty-first anniversary of University College, Cardiff, on October 14, it was stated that Lord Tredegar had promised £5,000 towards the cost of the new buildings shortly to be erected in Cathays Park; other sums were also promised amounting in all to £13,000. Between £70,000 and £80,000 are now available for the erection of the new buildings.

The registration of Harvard University is as follows: College, 2,002; Lawrence Scientific School, 524; graduate school, 358; divinity school, 42; law school, 731; medical school, 298; dental school, 109; making in all, 4,064; not counting Radcliffe College and the summer school. These figures represent a loss of about 200 students as compared with last year.

Registration figures at Cornell University show a total of 2,857, against a total last year of 2,656, a gain of 201. The distribution among the various colleges is: Arts, 648; law, 213; civil engineering, 377; Sibley, 1,040; agriculture, 178; veterinary, 104; medicine, 82; architecture, 68; graduates, 147. The greatest increase is 90 in Sibley College. These figures do not include the medical school in New York City.

Dr. F. S. Luther, since 1883 professor of mathematics at Trinity College, was installed as president of the institution on October 26. On the same day Dr. W. E. Huntington was installed as president of Boston University.

J. Culver Hartzell, Ph.D. (Munich), has been appointed professor of geology in the University of the Pacific.

Foster P. Boswell, Ph.D. (Harvard, 1904), has been appointed assistant in psychology; and Edwin Lee Norton, instructor in philosophy, in the University of Wisconsin.

Mr. H. M. Macdonald, F.R.S., has been appointed professor of mathematics in the University of Aberdeen.

SCIENCE

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*DEVELOPMENT OF MORPHOLOGICAL CONCEPTIONS.**

ANY outline of the progress of biology during the century commemorated by this exposition that is compressed within a single address must be either inadequate or must restrict itself to some single point of view. The latter alternative must be the one chosen, not only on account of the vastness of the material, but chiefly that personal experience may give some value to the presentation. In the present address, therefore, certain limitations become necessary, and in this case they are very natural.

In the first place, it would be presumptuous in me to include zoology in any review of progress, for botanists, as a rule, are strictly limited by their material, and have never confounded botany with biology. It is true that such subjects as morphology and physiology are not to be limited by any barrier that may be set up between plants and animals, but it is also true that the material and literature with which one is familiar do not often cross this barrier. At the same time, I think it must be recognized that botany and zoology have been mutually stimulating, every real advance in the one having given an impetus to the other, and that, as a consequence, their progress has been largely along parallel lines. Hence a review of any phase of the progress of the one may serve as an indication of the progress of the other.

* Address delivered at the International Congress of Arts and Science, St. Louis, September, 1904.

In the second place, to outline the progress of biology even from the standpoint of botany is too large a subject to be included in the grasp of any one man in such a way that he can recognize the movements in his own experience. The general botanist no longer exists except in name, and any general survey of botanical activity would have to be a compilation rather than a contribution. With these limitations, it becomes necessary for me to restrict myself largely to such an outlook as is given by plant morphology, and even then to speak only of those conclusions that come naturally to one in contact with the morphology of vascular plants. And yet I believe that a history of the development of the fundamental conceptions of plant morphology may be taken as a fair illustration of what has been going on not only in botany in general, but also in biology.

In the third place, the period included in this survey of plant morphology need not extend beyond the middle of the last century, for at least three reasons: (1) The earlier progress of the science has been outlined by Sachs in his admirable 'History of Botany'; (2) modern morphology finds its beginnings in a very real sense in the work of Hofmeister; and (3) Darwin's theory of natural selection gave the strong evolutionary impulse that it has felt ever since.

My principal theme, therefore, is the development of morphological conceptions, as illustrated by plant morphology.

It would be confusing to introduce the mass of details and the names of investigators suggested by this subject. Nor would there be any advantage in recording the changes of conceptions in reference to the great variety of structures developed by the plant body and in reference to their relation to one another. My purpose is to illustrate the general change of attitude, the shifting of the point of view in reference to plant organs as knowledge has increased. No definite names or dates can be cited, for the movement has been general and gradual, developed out of common experience and proceeding from the background of accumulated knowledge. Disregarding the numerous possible subdivisions, the attitude of mind towards a plant organ during the last half century has presented three distinct phases.

1. THE PHASE OF THE MATURE ORGAN.

At the beginning of the period under consideration, the morphologist concerned himself chiefly with completed organs, and an overshadowing rigid taxonomy compelled the idea of their classification. A few theoretical types of organs had been selected, and all organs were forced by the doctrine of metamorphosis to lie upon this procrustean bed. All parts of vascular plants, for example, were regarded as roots, stems or leaves under various disguises. It does not seem unreasonable to characterize this conception as the arbitrary selection of an ideal type, the natural offspring of the conception of ideal types that prevailed in taxonomy. In other words, morphology was dominated by taxonomy, and morphologists were first and chiefly taxonomists. It is this phase of morphology that must continue to be exploited chiefly by taxonomists, and which still remains in those conservative schools in which instruction lags far behind research. This doctrine of types resulted in the cataloguing of organs just as species were being catalogued, and, although capable of recording material, was incapable of advancing knowledge.

An accompaniment of this mental attitude was the explanation of metamorphoses. It is almost impossible for one age to conceive of the mental condition that was satisfied with the explanations of a previous age. In this case it must be remem-

bered that the earlier botanists were either ecclesiastically trained or not trained at all, and to them it was entirely satisfying to explain all metamorphoses upon teleological grounds. It is a matter of great surprise, however, to note how this point of view is still maintained by some investigators who have abandoned the doctrine of types, and in every other respect are inhaling a modern atmosphere.

One serious result of belief in the doctrine of types was the use of the most complex structures to explain the simpler ones; the reading of complexity into simplicity. For example, the type flower selected was one that had become completely differentiated; in short, a highly organized flower. This was read into all simpler flowers, and was even carried over the boundary of angiosperms and applied among gymnosperms, to the utter confusion of terminology and understanding. Fortunately for the students of cryptogams, a great gulf was thought to be fixed between plants with seeds and those without, and this the flower did not cross.

It is safe to say that this phase of morphology, with its types, and teleology, and simplification of complex structures, is now in its decline.

2. THE PHASE OF THE STRUCTURE OF THE DEVELOPING ORGAN.

This type of morphology has chiefly characterized the period under consideration. Its fundamental conception is evolution; its purpose is to discover phylogeny; and its method is based upon the belief that ontogeny recapitulates phylogeny. As a consequence, there was developed for the first time what may be called a philosophy of the plant kingdom, organizing the details of morphology into one coherent whole about such central facts as alternation of generations and heterospory. Study of the metamorphoses of plant organs was replaced by a study of their development and of 'life-histories,' and the earliest stages of gametophyte and sporophyte and reproductive organs were scrutinized and recorded in the greatest detail in the search for relationships. Shifting its center of gravity from the mature organ to the nascent organ, morphology departed very far from special taxonomy, while at the same time it was laying the solid foundation for general taxonomy. The reversal of old ideas was conspicuous, and much of the old terminology was found to be false in suggestion and almost impossible to shake off. For example, it has been a constant surprise to me to see the persistent use of a sex terminology in connection with flowers by those who must know better, and who must know also that they are helping to perpetuate a radical misconception.

A still more important result of this change of front in the morphological attack was the necessary reversal of the method of interpretation. No longer was the flower of highly organized angiosperms read down into the structures of the lower groups; but from the simplest beginnings structures were traced through increasing complexity and seen to end in the flower, explaining what it is. This meant that evolution had replaced the old idea of types and metamorphosis, and was building facts into a structure rather than cataloguing them. This spirit of modern morphology has not as yet dominated instruction. Its facts are developed in all their detail, abundantly and skilfully, but very seldom do the facts seem to be coordinated. The old spirit of accumulating unrelated material still dominates teaching, and crams the memory without developing permanent tissue.

The detailed developmental study of plants and their organs gave rise to what has been called morphological cytology, but it is an unfortunate differentiation, for cytology merely pushes the search for

structure to the limits of technique. It is becoming more and more clear that every morphologist must also be a cytologist; and certainly every cytologist should be a morphologist; and there is no more reason for differentiation on this basis than on the basis of objectives used.

While fully recognizing the magnificent development of morphological knowledge that has resulted from this point of view, it is interesting to note running all through it much of the rigidity of the older morphology, leavened to a certain extent by the demands of evolution. Certain definite morphological conceptions were established, and organs were as rigidly outlined and defined as under the old regime. For example, there were no more definite morphological conceptions than sporangium, antheridium and archegonium. Unconsciously, perhaps, a type of each was selected, this time from their display in the lower plant groups; and this type was read into the structure of higher groups. The distinctly outlined antheridia and archegonia of bryophytes were compelled to remain just as distinct of definition when they become confused among surrounding tissues in the pteridophytes; and the beautifully distinct sporangium of the leptosporangiates compelled the idea of an imbedded sporangium among the eusporangiates. In other words, the concept included non-essential with essential structures, a distinct wall about a sporangium being just as much a part of the definition as the sporogenous tissue, and its presence compelled even in the absence of any occasion for it. It can hardly be doubted that this was a heritage of habit from the older morphology, for it is in a sense a continuation of the conception of types. The recent morphologist who traces a sporangium wall into an anther is the same in spirit as the older morphologist who saw in the stamen a transformed leaf.

Associated with this rigidity of conception as to structure was the idea of predestination, and search was made for the cell or cell-group that was foreordained to produce a given structure. There was no idea that the fate of these cells might be changed or that other cells might share it. The repeated attempts to discover an exact definition of the term archesporium will serve as an illustration; and the repeated failures should have warned sooner than they did. Indifference of primordia was not thought of, and each living cell was conceived of as having only a single possibility.

The idea of unvarying sequence and predestination not only entered into the conception of developing organs, but also directed an immense amount of work in connection with the early embryonic stages of both gametophyte and sporophyte. So far as my own experience is concerned, it was in this connection that the conception of rigidity broke down. The multiplication of observations caused definite sequence and predestination to vanish in a maze of variations. This type of morphology was necessarily its own corrective, for rigidity could not stand before the accumulation of facts. In a sense, rigidity of conception is easier to grasp and certainly simpler to present than flexibility of conception, for the human mind seems to demand its knowledge in labeled pigeon-holes. This same spirit permeated the attitude of the morphologist of this period towards his ultimate purpose, for phylogeny to him was rather a simple conception. Similarity of structure meant community of descent. Such a condition as heterospory, such a structure as the seed, or such an organization as the sporophyte was attained once for all, and the successful plant or group became the fortunate ancestor of all heterosporous plants, or spermatophytes, or sporophytes. This was phylogeny made easy. Multiplied observations showed that simi-

larity of structure often does not indicate community of descent, and we are staggered before the possibilities of phylogeny.

The division of morphology that we have been pleased to call cytology has had the same experience. It was hoped that the more fundamental structures would show some reasonable constancy of phenomena, some rigidity in detail; but we have been confronted here again by endless variation, and hence most diverse interpretation of results.

Clearly, belief in a rigid sequence or in predestination could not be maintained; and in a real sense morphologists have been cataloguing material for study, and their real problems lie behind these endlessly variable details.

The phase of morphology just described has certainly dominated during the last half century, with phylogeny as its chief stimulus, and a rigidity of conception that only a multitude of facts could break down. It is a type that must always exist, as taxonomy must always exist, and it must be considered fundamental in familiarizing with material; but, perhaps, it may be said now to be at its culmination as the dominant phase.

3. THE PHASE OF THE INFLUENCE OF CHANGING CONDITIONS UPON THE DEVELOPING ORGAN.

This means experimental morphology, and so far as organs are concerned its purpose is to discover the conditions that determine their structure and nature. All idea of rigidity has disappeared in the fundamental conception of the capacity of living cells to respond to varying conditions. What may be the possibilities of variation, and what may be the exact conditions responsible for variations, are questions to be answered by experiment. If the oldest morphology is in its decline, and the current morphology at its culmination, experimental morphology may be said to be in its inception. It is easier to judge of a movement at its decline or culmination than at its inception, and experimental morphology as yet is fuller of promise than of performance. In any event, it was an inevitable phase when multiplied variation had broken down the conception of rigidity. The fundamental question of the possibilities of living cells is immediately confronting us; and the range of these possibilities may be considered under three heads.

1. *The Varying Structure of an Organ.*—Perhaps leaf variation, which enters so largely into taxonomy, may be used as an illustration. When under experimentation leaves can be made to vary from narrow to orbicular, from dissected to entire, and the exact physical condition determined that induces the result, any idea of rigidity in the form or structure of an organ must disappear. An observed narrow range of variation in nature may be regarded as an indication of the narrow range of conditions rather than of the narrow range of possible response on the part of the organ. From this point of view an organ is represented by its essentials, without reference to its non-essentials, and so we are now thinking of sporangia in terms of sporogenous tissue, without reference to the presence or absence of a morphologically constant wall; of archegonia as axial rows of potential eggs, without concern for an exact morphological definition of the sterile jacket. The main question is, what determines the formation of sporogenous tissue rather than of sporangia; what determines the formation of eggs or sperms, rather than of archegonia and of antheridia?

2. *The Possibilities of Primordia.*—This has to do with what I have called the doctrine of predestination. It is more than a question as to the variable form or structure of an organ; it is a question as to

variable nature of an organ that may arise from a given primordium. When primordia that usually develop microsporangiate organs produce megasporangiate ones, or *vice versa;* when the same plant body produces sporangia or gametangia in response to conditions imposed by the experimenter; it becomes evident that primordia may be indifferent not only as to form, but also as to nature.

This meant a general unsettling of morphological conceptions. To find, for example, that a given cell is not set apart from its first appearance to function as an archesporial cell, but that there are as many potential archesporial cells as there are cells in an extensive tissue; and further to find that the archesporial cell when discovered by its functioning does not necessarily produce all the sporogenous tissue, is to abandon the idea of predestination and of defining structures on a rigid morphological basis.

3. *The Origin of Species.*—Probably the greatest triumph of experimental morphology thus far is that it has put the problem of the origin of species upon an experimental basis. The ability to vary, and to vary promptly and widely, when considered in connection with structures used by taxonomists, means new species under certain conditions. To analyze these conditions is a problem of enormous complexity, but to have the problem clearly before us is but the prelude to its solution. There is still a tendency to call things inherent that are not apparent, but this is a habit not easily outgrown, and such a problem as the origin of species will long have its convenient category of 'inherent tendencies.'

Certain conclusions are inevitable as one considers the perspective opened by experimental morphology.

In the first place, it would seem that what we have called 'biological laws' are also the laws of physics and chemistry, and the experimenter must be prepared to use all the refinements of method developed by physicists and chemists. Much of the work done in the name of experimental morphology is as yet crude in the extreme, and we are often left with a confusing plexus of conditions rather than with a satisfactory analysis. To grow plants, to observe certain results and to draw conclusions, too frequently means the arbitrary or ignorant choice of one factor out of a possible score to be found in the uncontrolled conditions.

In the second place, that phase of ecology which deals with what are called 'adaptations to environment' simply catalogues the materials of experimental morphology and must be merged with it. To retain it as a distinct field of work is to doom it to sterility, for it can only bear fruit as it becomes an experimental subject, and then it is experimental morphology.

In the third place, experimental morphology, with its background of physics and chemistry, is more closely related to physiology than it is to the older phases of morphology; which leads to the conclusion that the fundamental problems of morphology are physiological. We may look at the situation from either standpoint, and say that the most recent phase of morphology entrenches upon physiology, or that the boundaries of physiology must be extended enough to include morphology. To-day the two subjects are handicapped; for morphologists are not physiologists enough to know how to handle and interpret their material, and physiologists are not morphologists enough to know the extent and significance of their material. The training of the future must not differentiate these two subjects still further, but must combine them for effective results.

This modern tendency to cross old-established boundaries between subjects is evi-

dent everywhere. Physiology and chemistry have long possessed common territory; plant morphology and physiology have now found no barrier between them. This simply means that so long as we deal with the most external phenomena our subjects seem as distinct from one another as do the branches of a tree; but when we approach the fundamentals we find ourselves coming together, as the branches merge into the trunk. The history of botany, beginning with taxonomy, has been a history that began with the tips of the branches and has proceeded in converging lines towards the common trunk. The fundamental unity of the whole science, in fact, of biological science, however numerous the branches may be, is becoming more and more conspicuous. Already the old lines of classification have become confused, and one looking through any recent list of papers finds it impossible to classify them in terms of the old divisions. Investigators are now to be distinguished by particular groups of problems in connection with particular material, and all problems lead back to the same fundamental conceptions. In other words, the point of view is to be common to all investigators, and until it is common their results will not reach their largest significance.

A fourth consideration is the result of all this upon taxonomy. It seems clear to one who was originally trained in taxonomy, and who has passed through all the phases of morphology described above, that the conception of species has become so radically changed that a reconstructed taxonomy is inevitable. When the doctrine of types disappeared, and when experimental morphology showed the immense possibilities of fluctuation in taxonomic characters, the taxonomy of the past was swept from its moorings. Taxonomy must continue its work as a cataloguer of material, but to catalogue rigid concepts is very different from cataloguing fluctuating variations. The attempt to do the latter on the old basis is being attempted in certain quarters, but it soon passes the limit of usefulness and sets strongly towards the record of individuals. Some new basis must be devised, and it must be a natural and useful expression of the relationships of forms as suggested by experimental morphology.

That this history of the progress of morphology, just outlined, is a fair indication of general tendencies may be illustrated from plant anatomy. This subject, not well differentiated from plant morphology among the lower groups, has developed a very distinct field of its own among vascular plants. Its early phase was that of classification, in which types of tissues were rigidly defined. This definite catalogue of tissues continued to be used after evolutionary morphology was well under way, and morphologists gradually abandoned any serious consideration of it, just as they had cut loose from the old taxonomy. In text-books the juxtaposition of morphology upon an evolutionary basis and a little anatomy upon a strictly taxonomic and artificial basis became very familiar.

Recently a second phase of anatomy has begun to appear, and we find it upon an evolutionary basis. Investigation has passed from the study of mature tissues to the study of developing tissues, and the seedling is more important to the anatomist than the adult body. As in the corresponding phase of morphology, the fundamental conception of this new phase is the theory of recapitulation, and its ultimate purpose is phylogeny. It views tissues as morphology views organs, and is attacking the same general problems. In so doing it becomes a special field of morphology, no more to be separated from it than are morphologists who study the sporophyte to

be separated from those who study the gametophyte. It is simply the development of another line of attack upon morphological problems. This anatomical morphology, as it may be called, has yet to accumulate its share of results, and there is no region of morphology more in present need of investigators. From the small beginnings it has made it is evident that it must check the conclusions of the older morphology at every point. Even now no statement as to phylogeny can afford to neglect the testimony of anatomy.

This second phase of anatomy promises to be accompanied by a third, which finds its parallel and probably its suggestion in experimental morphology. In its incipient stage it is known as ecological anatomy, just as another phase of ecology preceded and then became merged in experimental morphology. Ecological anatomy can make no progress until it becomes an experimental subject, and then it is experimental anatomy, which holds the same relation to experimental morphology that evolutionary anatomy holds to evolutionary morphology. In other words, it is the same subject, with the same methods and purpose, and differing only in the structures investigated. And thus anatomy reaches the physiological basis, and as a part of morphology fills out the structures to be investigated from this standpoint.

There remains a region of ecology so vast and vague that it must be considered by itself for a time. It deals with such complex relationships as exist between soil, topography, climate, etc., on the one hand, and masses of vegetation, on the other. Just because it is vast and vague ought it to be attacked. The little incursions that have been made indicate the possibilities. It evidently includes some of the great ultimate problems. As yet it can not define itself, for it seems to have no boundaries. Its materials were evident but entirely meaningless in the earlier history of botany, for it needed all of our progress before it could begin to ask intelligent questions. By virtue of its late birth it promises to develop more rapidly than any other phase of botany. And yet, beyond the inevitable preliminary classification of material, its real progress is measured by its experimental work conducted upon a definite physiological basis. Tentative generalizations are numerous and necessary, but they are merely suggestions for experiment. When one understands the close analysis necessary in the simplest physiological experiment, the problems suggested by this phase of plant ecology are appalling; but I see in the whole subject nothing but the largest application of physiology to the plant kingdom.

And now that the various phases of botany all seem to rest upon physiology, it must be apparent that the most fundamental problems are physiological. It is only recently that the development of plant physiology has justified this relationship. Its own history has been one of progress from the superficial towards the fundamental, from the behavior of a plant organ to the behavior of protoplasm. And here it becomes identified with physics and chemistry; and in a very real sense botany has become the application of physics and chemistry to plants.

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*THE CONCEPTS AND METHODS OF SOCIOLOGY.**

To set forth in a brief paper the fundamental conceptions of any modern science is a difficult task. The difficulty increases as we pass from the relatively simple sciences that have to do with inorganic matter,

* An address delivered at the International Congress of Arts and Science, Department of Sociology, September, 1904.

to the highly complex sciences of life and of mind. And when we come to the phenomena presented by aggregations of living beings—phenomena of the interaction of mind with mind, phenomena of the concerted activity of many individuals working out together a common destiny—we have a subject for scientific study too many-sided, too intricate, for description in a few comprehensive phrases, and the scientific study itself arrives at fundamental conceptions only after a long and extensive process of elimination. Fundamental conceptions in such a field are necessarily general truths, expressing the relations that endless facts of detail bear to one another, or to underlying groupings, processes or causes. A brief account, therefore, of the fundamental conceptions of sociology, and of the methods available for the scientific study of society, must remorselessly exclude those concrete particulars that lend to our knowledge of collective life its preeminently real—its human —interest. It must be restricted to conceptions that are elemental, general and in a degree abstract.

Conforming to this necessity, I shall group the fundamental conceptions of sociology in three divisions, namely: (1) Concepts of the subject-matter of sociological study, that is to say, of society; (2) concepts pertaining to the analysis and classification of social facts, and incidentally to the corresponding subdivisions of sociological science; (3) concepts of the chief processes entering into social evolution, and of the inferred causes.

The word 'society' has three legitimate significations. The first is that of the Latin word *societas*, meaning 'companionship,' 'good-fellowship,' 'pleasurable consorting together,' or meaning the individuals collectively regarded that consort. Examples of society in this original sense are afforded by the commingling of familiar spirits at the tavern or the club, the casual association of chance acquaintances at the summer resort, the numberless more formal 'functions' of 'the season.' In the second signification of the word, 'society' is a group of individuals cooperating for the achievement of any object of common interest or utility, as, for example, a merchant guild, an industrial corporation, a church, a congress of arts and science. Finally, in the third signification of the word, 'society' is a group of individuals dwelling together and sharing many interests of life in common. A nest of ants, a savage horde, a confederation of barbarian tribes, a hamlet or village, a city-state, a national state, a federal empire—all these are societies within the third and comprehensive definition of the term. A scientific conception of society must lie within the boundaries fixed by these three familiar meanings, but it must seize upon and make explicit the essential fact, whatever it may be, that is a common element in all social relations.

At the present time we find in sociological literature two competing conceptions of the essential nature of society. They are known respectively as the organic and the psychological conception.

The organic conception assumes that the group of individuals dwelling and working together is the true, or typical, society, and that it is as much a unity, although made up of individuals, as is the animal or the vegetal body, composed of cells and differentiated into mutually dependent tissues and organs. Sketched in bold outlines by Herbert Spencer in his essay on 'The Social Organism' in 1860, the organic conception has been elaborated by Schäffle and Lilienfeld, and is to-day accepted as the working hypothesis of an able group of French sociologists, whose work appears in the proceedings of L'Institut international de Sociologie.

The psychological conception assumes that, whether or not the organic conception be true and of scientific importance, it fails to get to the bottom of things. It assumes that, even if society is an organism, there is necessarily some interaction of individual with individual, or some form of activity common to all individuals that serves to bind them together in helpful and pleasurable relations, and that this activity, instead of being merely physical, like the cohesion of material cells, is a mental phenomenon. It assumes that all social bonds may be resolved into some common activity or some interactivity of individual minds. It is, in short, a view of society as a mode of mental activity.

This is the psychological conception in general terms. It takes, however, four specific forms in attempting to answer the question: What definite mode of mental action is the most elementary form of the social relation?

According to the most pretentious of these answers, one that dates back to Epicurus, and lies at the basis of all the covenant or social contract theories of political philosophy, the psychological origin of society is found in a perception of the utility of association. It assumes that men consciously and purposely create social relations to escape the ills of a 'state of nature' and to reap the rewards of cooperation. This rationalistic theory offers a true explanation of highly artificial forms of social organization in a civil, especially an industrial, state, but it throws no light upon the nature of elemental, spontaneous cooperation. For this we must turn to the other three conceptions —all of them, I venture to think, modernized forms of certain very ancient notions.

According to one of these, the most elementary social fact is seen in the constraining power, the impression, the contagious influence that an aggregation, a mass, of living beings, exerts upon each individual mind. Society is thus viewed as a phenomenon closely allied to suggestion and hypnosis. This view of society is most fully set forth in the writings of Durkheim and Le Bon.

A third conception, identified with the life-work of our lamented colleague, Gabriel Tarde, assumes that impression, contagion, influence, as forms of the interaction of mind with mind, may themselves be accounted for. It explains them as modes of example and imitation. All society is thus resolved into products of imitation.

In strict psychological analysis these 'impression' and 'imitation' theories must be classed, I think, as scientifically developed forms of the 'sympathy' theories of society, that may be traced back through the literature of political philosophy to very early days. They offer proximate explanations of the great social facts of resemblance, of mutuality, of solidarity; but do they, beyond a doubt, trace concerted activity back to its absolute origin? Above all, do they account not only for similarity, but also for variation, for the differentiation of communities into leaders and followers, for competition as well as for combination, for liberty as well as for solidarity?

The fourth conception, put forth some years ago by the present writer, should be classed as a developed form of the instinct theory, dating back to Aristotle's aphorism that man is a political animal. It assumes that the most elementary form of social relationship is discovered in the very beginning of mental phenomena. In its simplest form mental activity is a response of sensitive matter to a stimulus. Any given stimulus may happen to be felt by more than one organism, at the same or at different times. Two or more organisms may respond to the same given stimulus simultaneously or at different times. They

may respond to the same given stimulus in like or in unlike ways; in the same or in different degrees; with like or with unlike promptitude; with equal or with unequal persistence. I have attempted to show that in like response to the same given stimulus we have the beginning, the absolute origin, of all concerted activity—the inception of every conceivable form of cooperation; while in unlike response, and in unequal response, we have the beginning of all those processes of individuation, of differentiation, of competition, which, in their endlessly varied relations to combination, to cooperation, bring about the infinite complexity of organized social life.

It is unnecessary to argue that this conception of society not only takes account of individuality as well as of mutuality, but that also it carries our interpretation of solidarity farther back than the theories of impression and of imitation, since both impression and imitation must be accounted for—in ultimate psychological analysis—as phenomena of reciprocal, or interstimulation and response. Indeed, the very language that Tarde uses throughout his exposition tacitly assumes as much. Example is stimulus, the imitative act is response to stimulus. The impression that the crowd makes upon an individual is stimulus, and the submission, obedience or conformity of the individual is response to stimulus. Moreover, the formation of the crowd itself has to be accounted for, and it will be found that, in many cases, the formation of a crowd is nothing more nor less than the simultaneous like-response of many individuals to some inciting event, circumstance or suggestion. In short, impression, imitation and conformity are specific modes, but not by any means the primary or simplest modes, of stimulation and response; and some of the most important phenomena of concerted action can be explained only as springing directly from primary like-responses, before either imitation or impression has entered into the process.

This conception meets one further scientific test. It offers a simple and consistent view of the relation between social life and the material universe. It assumes that the original causes of society lie in the material environment, which may be regarded as an infinitely differentiated group of stimuli of like-response, and, therefore, of collective action; while the products of past social life, constituting the historical tradition, become in their turn secondary stimuli, or secondary causes, in the social process.

A mere momentary like-response by any number of individuals is the beginning of social phenomena, but it does not constitute a society. Before society can exist there must be continuous exposure to like influences, and repeated reaction upon them. When this happens, the individuals thus persistently acting in like ways become themselves mentally and practically alike. But likeness is not identity. The degrees of resemblance or of difference in the manner of response to common stimuli manifest themselves as distinguishable types of mind and of character in the aggregate of individuals; while the differing degrees of promptitude and persistency in response have as their consequence a differentiation of the aggregate into leaders and followers, those that assume initiative and responsibility, and those that habitually look for guidance. These differences and resemblances have subjective consequences. Differing individuals become aware of their differences, resembling individuals become aware of their resemblances, and the consciousness of kind so engendered becomes thenceforth a potent factor in further social evolution.

Summarizing our analysis to this point, we may say that we conceive of society as

any plural number of sentient creatures more or less continuously subjected to common stimuli, to differing stimuli, and to inter-stimulation, and responding thereto in like behavior, concerted activity or co-operation, as well as in unlike, or competitive, activity; and becoming, therefore, with developing intelligence, coherent through a dominating consciousness of kind, while always sufficiently conscious of difference to insure a measure of individual liberty.

Which of these various conceptions of the ultimate nature of the social relation shall in the long run prevail must depend upon a certain fitness to account for all the phenomena of social life in the simplest terms. That fitness can be determined only through the further evolution of social theory.

But whatever the finally accepted view may be, there are certain classifications of social facts that may be accepted as among the elementary notions of any sociological system.

And first there are types or kinds of societies. The broadest groupings correspond to the familiar demarkations made by natural history. There are animal societies and human societies; and the human societies are further divided into the ethnic—or communities of kindred, and the civil—or communities composed of individuals that dwell and work together without regard to their blood-relationships.

More significant for the sociologist, however, is a classification based on psychological characteristics. The fundamental division now is into instinctive and rational societies. The bands, swarms, flocks and herds in which animals live and cooperate, are held together by instinct and not by rational comprehension of the utility of association. Their like-response to stimulus, their imitative acts, the frequent appearance among them of impression and submission, are all purely instinctive phenomena. Not so are the social relations of human beings. There is no human community in which instinctive like-response to stimulation is not complicated by some degree of rational comprehension of the utility of association.

The combinations, however, of instinct and reason are of many gradations; and the particular combination found in any given community determines its modes of like-response to stimulus and its consciousness of kind—establishes for it a dominant mode of the relation of mind to mind, or, as Tarde would have phrased it, of inter-mental activity. This dominant mode of inter-mental activity—inclusive of like-response and the consciousness of kind—is the chief social bond of the given community, and it affords the best distinguishing mark for a classification of any society on psychological grounds. So discriminated, the kinds of rational or human societies are eight, as follows:

1. There is a homogeneous community of blood-relatives, composed of individuals that from infancy have been exposed to a common environment and to like circumstances, and who, therefore, by heredity and experience are alike. Always conscious of themselves as kindred, their chief social bond is sympathy. The kind or type of society, therefore, that is represented by a group of kindred may be called the sympathetic.

2. There is a community made up of like spirits, gathered perhaps from widely distant points, and perhaps originally strangers, but drawn together by their common response to a belief or dogma, or to an opportunity for pleasure or improvement. Such is the religious colony, like the 'Mayflower' band, or the Latter-Day Saints; such is the partisan political colony, like the Missouri and the New Eng-

land settlements in Kansas; and such is the communistic brotherhood, like Icaria. Similarity of nature and agreement in ideas constitute the social bond, and the kind of society so created is therefore appropriately called the congenial.

3. There is a community of miscellaneous and sometimes lawless elements, drawn together by economic opportunity—the frontier settlement, the cattle range, the mining camp. The newcomer enters this community an uninvited but unhindered probationer, and remains in it on sufferance. A general approbation of qualities and conduct is practically the only social bond. This type of society, therefore, I venture to call the approbational.

The three types of society thus far named are simple, spontaneously formed groups. The first two are homogeneous, and are found usually in relatively isolated environments. The third is heterogeneous, and has a transitory existence where exceptional economic opportunities are discovered on the confines of established civilizations.

Societies of the remaining five types are in a measure artificial, in part created by reflection—by conscious planning. They are usually compound, products of conquest or of federation, and, with few if any exceptions, they are of heterogeneous composition. They are found in the relatively bountiful and differentiated environments.

4. A community of the fourth type consists of elements widely unequal in ability; the strong and the weak, the brave and the timorous, exploiters and the exploited—like enough conquerors and the conquered. The social bonds of this community are despotic power and a fear-inspired obedience. The social type is the despotic.

5. In any community of the fifth type arbitrary power has been established long enough to have identified itself with tradition and religion. Accepted as divinely right, it has become authority. Reverence for authority is the social bond, and the social type is, therefore, the authoritative.

6. Society of the sixth type arises in populations that, like the Italian cities at their worst estate, have suffered disintegration of a preexisting social order. Unscrupulous adventurers come forward and create relations of personal allegiance by means of bribery, patronage, and preferment. Intrigue and conspiracy are the social bonds. The social type is the conspirital.

7. Society of the seventh type is deliberately created by agreement. The utility of association has been perceived, and a compact of cooperation is entered into for the promotion of the general welfare. Such was the Achæan League. Such was the League of the Iroquois. Such was the confederation of American commonwealths in 1778. The social bond is a covenant or contract. The social type is the contractual.

8. Society of the eighth type exists where a population collectively responds to certain great ideals, that, by united efforts, it strives to realize. Comprehension of mind by mind, confidence, fidelity and an altruistic spirit of social service, are the social bonds. The social type is the idealistic.

Of these varieties of society the higher, compound communities, or commonwealths, may, and usually do, include examples of the lower types, among their component groups.

All of these eight types, and the instinctive type exhibited by animal bands, have been observed from the earliest times and have suggested to social philosophers as many different theories of the nature of society. Thus in the totemistic lore of savagery we find endless suggestions of an instinct theory. In the mythologies of tribally organized barbarians we find sym-

pathy, or natural brotherhood, theories, which later on are borrowed, adapted and generalized by the great humanitarian religions, like Buddhism and Christianity. Suggested by societies of congenial spirits we have the consciousness-of-kind theories, voiced in the proverb that 'birds of a feather flock together,' in the saying of Empedocles that 'like desires like,' in the word of Ecclesiasticus that 'all flesh consorteth according to kind, and a man will cleave to his like.' From approbational societies have come our natural-justice theories. From despotic societies have come our political-sovereignty theories that 'might makes right,' in the sense of creating law and order. From authoritative societies have come theories of the divine right of kings; from conspiritual societies have come Machiavelian theories of the inevitableness of intrigue and conspiracy; and from societies long used to deliberative assemblies, to charters of liberty and bills of rights, have come the social-covenant or contract theories of Hobbes, Locke and Rousseau. Finally, from societies that have attained the heights of civilization have come the Utopian theories, from Plato until now.

Whatever the kind or type of the society, there are found in it four great classes or groupings of facts.

Every society presupposes a certain number of concrete living individuals. The basis of every society, therefore, is a population. Every social population offers for observation phenomena of aggregation, or distribution of density; phenomena of composition, by age, sex and race; and phenomena of amalgamation or unity.

The social life, however, as we have seen, is a phenomenon of mind, and the varied modes that the common activity and interplay of minds assume, present the second great class of social facts. These facts of the social mind, as we may call them, include the phenomena of stimulation and response in their generic forms; phenomena of resemblances and differences, that is to say, of types; phenomena of the consciousness of kind; and phenomena of concerted volition.

The common mental activity, taking habitual forms, creates permanent social relationships, that is to say, a more or less complex social organization. In this we meet the third great class of social facts. Two general forms may be observed. In one form, individuals dwell together in groups that, by coalescence and federation, compose the great compound societies. These groups collectively may be called the social composition. In the other form, individuals, with more or less disregard of residence, combine in associations to achieve specific ends. Such associations collectively represent the social division of labor, and, therefore, may be called the social constitution. In its entirety and in its subdivisions the social organization is of one or another type, according as it is on the whole coercive, or on the whole liberal, in character.

The fourth class of social facts pertains to the great end, to the attainment of which the social organization is a means. That end is the social welfare. The social welfare is seen in its most general form in certain public utilities, including security, justice and liberty, material prosperity and popular culture. It is seen finally in the type of personality that the social life creates, and which must be studied as vitality, mentality, morality and sociality.

Not every society individually considered survives long enough to pass through all the possible stages of social evolution, but society in the aggregate, and in historic continuity, displays to us four distinguishable stages of evolutionary advance. There is, first, the stage of zoogenic association,

in which the mutual aid and protection practised by animal bands plays an enormously important part in the differentiation of species and in the survival of those best endowed with intelligence and sympathy. There is, next, the stage of anthropogenic association, in which, through unnumbered ages, the creature that was destined to become man was acquiring the distinctly human attributes of language and reason. There is, later on, the stage of ethnogenic association, wherein is evolved that complex tribal organization characteristic of savage and barbarian life. Finally, there is the stage of civic or demogenic association, in which great peoples outgrow tribal organization, and create a political organization based on common interests, irrespective of blood-relationships.

These categories of social fact have established certain natural subdivisions in social science. Corresponding to the historical order we have, first, studies in animal sociology; second, studies of primitive human culture; third, the great sciences of ethnography and ethnology, investigating tribally organized mankind; and, fourth, history, the narrative and descriptive account of the evolution of civil society. Corresponding to the four great divisions of phenomena in contemporaneous society we have, first, demography, or the study of social populations; second, social psychology, and the culture-studies of comparative philology, comparative art, comparative religion, and the history of science, all of which are investigations of the social mind; third, the political sciences, devoted to a study of social organization; and fourth, such sciences of the social welfare as political economy and ethics, the scientific study of education, studies of pauperism and criminology.

Such being our conceptions of the nature of society, and of the proper analysis and classification of social facts, let us pass on to examine our concepts of the great processes of social evolution, and of the causes in operation.

We accept the evolutionist point of view, and regard all the transformations that occur within any social group as a phase of that ceaseless equilibration of energy taking place throughout the universe. Every finite aggregate of matter is in contact or communication with other finite aggregates, no two of which are equally charged with energy. From the aggregate more highly charged, energy is given off to aggregates that are undercharged, and in this process the strong absorbs, or disintegrates, or transforms, the weak. Every social group, animal or human, since time began, has been in ceaseless struggle with its material environment and with other social groups. Whatever has happened to it or within it is most intelligibly accounted for if we view the process as one of equilibration of energies, between the group and its environment, or between group and group, or between unequal and conflicting elements within the group itself.

The modes that this equilibration assumes are many.

There is, first, the external equilibration of the society with its surroundings. This gives rise to the processes of migration, in which populations move from place to place, in search of new food supplies. Social groups are thus brought into conflict with one another, and the activities of militarism are engendered.

There is, next, a process of combined external and internal equilibration. Migration is its chief manifestation, but the migration is not now one of entire populations organized for war and conquest. It is one of individuals or families, moving from land to land in search of economic opportunity or of religious or political liberty, and its consequence is that exceeding

heterogeneity of the demotic composition which is seen, for example, in the population of the United States.

There are, thirdly, the processes of internal equilibration. First among these is the differentiation of the mind of the population, consequent upon some degree of unlikeness and inequality in the responses of differing individuals to the common stimuli to which all are subjected. This is followed by the segregation of resembling products into types and classes. Secondly, there is an evolution of the consciousness of kind, with increasing attention to means of communication and association. Thirdly, there is a struggle between strong individuals and weak, between leaders and followers, between strong and weak classes. This equilibration may take one of three possible forms: (1) The subjugation and perhaps the enslavement of the weak by the strong; (2) economic exploitation; (3) the uplifting of the weak by the strong through education, justice and economic aid. The moral advance of society is a progress from equilibration through subjugation and exploitation to equilibration through uplifting, and it depends upon the broadening and deepening of the consciousness of kind.

A fourth phase of internal equilibration appears in the struggle among differing groups of the like-minded in the community. Some elements of the population are sympathetically emotional, or are alike in beliefs or dogmas. Others are alike intellectually, rationally; they attain agreement through deliberation. In every community the reasoning and the unreasoning elements are in perpetual conflict.

To the extent that the community is controlled by its deliberative element, it exhibits a policy—a more or less consistent attempt consciously made to control its destiny. In the history of human society there have been three great groups of policies, namely: (1) policies of unification —attempts to make all members of the community alike in type, in belief and in conduct; (2) policies of liberty—attempts to give wide scope to individual initiative; (3) policies of equality—attempts to prevent the disintegration of society through an excess of individual liberty. The struggle of conflicting interests in the community, which these three modes of policy represent, is yet another form of internal equilibration.

To the extent that a policy of equality is adopted, the community is democratic. Political equality, equality before the law, and some approach toward equality of economic opportunity, are the essential elements of democracy. No sooner is democracy evolved than we see a struggle between the forces that make for absolutist, and those that make for liberal, democracy. Either the majority is permitted to rule at will, or it is compelled to leave inviolate certain rights of the minority and of individuals.

The outcome of all equilibration, external and internal, is a certain relation of the individual to the social organization. In low types of society the individual literally belongs to the various social groups in which his lot is cast. He belongs to them for life. To leave them is to become an outcast. He may not leave his clan, his guild, his caste, his church, or his state. In superior types of society we discover a high degree of individual mobility combined with a marvelous power to concentrate enormous numbers of individuals in moments of emergency, upon any work needing to be done. The individual may go freely from state to state, from parish to parish, in search of his best economic opportunity. He may sever connection with his church to join another, or none at all. He may be a director to-day in a dozen corporations, and to-morrow in a

dozen different ones. The goal of social evolution is a complex, flexible, liberal organization, permitting the utmost liberty and mobility to the individual, without impairing the efficiency of organization as a whole.

On the methods of sociology remark at this time must necessarily be brief.

Dealing as we do with highly concrete materials, we place our main reliance upon systematic induction. The experimental method of induction, however, is of little avail in the scientific study of society. Although social experimenting is at all times going on, it is difficult to isolate causes or to control conditions with scientific thoroughness. Observation, therefore, and critically established records of observations made in bygone days, must be our main dependence, so far as the accumulation of data is concerned.

Yet in a field so vast, observation itself would be a fruitless toil if it were not directed by scientific rules. Canons of guidance we find in the so-called comparative and historical methods. Selecting any social fact, or correlation of facts, observed in any given society, we systematically search for a corresponding fact or correlation in all contemporaneous societies, animal and human, ethnic and civil. This search has one clearly defined object, namely, to determine whether the observed fact is a universal, and therefore an essential, an elementary phenomenon of society, and, if it is not universal, to ascertain just how wide its distribution is. By such research we discover those resemblances and differences in social phenomena that are the bases of scientific classification.

Having in this manner arrived at a scheme of classification, we use it in subsequent observation precisely as the chemist or the botanist uses the classifications that have been established in his science. We systematically look for the facts and the correlations that the classification leads us to anticipate.

In like manner, following the historical method, we search for a given social fact at each stage in the historical evolution of a given society, and thereby determine what social phenomena are continuous.

A complete scientific theory of natural causation is established only when our knowledge becomes quantitatively precise. Often the law that we seek to formulate eludes us until the correlations of phenomena have been determined with mathematical exactness. Sociology has unjustly been reproached for neglecting that attention to precision which is the boast of other sciences. The indictment of vagueness may be a true bill against individual sociologists. It is demonstrably not a true bill against sociology. It is to the scientific students of sociology that the world owes the discovery and development of an inestimably valuable form of the comparative and historical methods, namely, the statistical method. Every inductive science to-day is adopting this method. Physics, chemistry, astronomy and geology would be helpless without it. The biologists have acknowledged their dependence upon it by the establishment of a statistical journal, *Biometrica*. It is not too much to claim that the possibilities of this now indispensable method of all the sciences were first demonstrated in the epoch-making social studies of Jaques Quetelet, and that its employment in sociology has been out of all proportion to its employment elsewhere. As developed in recent years by Westergaard, the Dane; by Germans, like Steinhauser, Lexis and Meyer; by Italians, like Bodio; by Frenchmen, like Levasseur and Dumont; by Englishmen, like Charles Booth, E. B. Tylor, Galton, Bowley and Karl Pearson; by Americans, like Mayo-Smith, Weber, Norton, Cattell, Thorndike and Boas, it has become,

and will continue to be, the chiefly important method of sociology; and assuredly, in the course of time, it will bring our knowledge of society up to standards of thoroughness and precision comparable with the results attained by any natural science.

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*RECENT ADVANCES IN THE ANALYSIS OF THE EARTH'S PERMANENT MAGNETIC FIELD.**

The 'earth is a great magnet' and as such is subject to the same laws which pertain to any other magnet—these are facts established by the experience of over four centuries. How and whence the earth has received its magnetism are questions we can not as yet answer, nor, in my opinion, shall we be able to answer them definitely until we have solved the problems as to the causes of the *variations* of the earth's magnetism. I firmly believe that when we have discovered the causes of the periodic and aperiodic variations, such as the diurnal variation, annual variation, secular variation and magnetic perturbations, we shall have strong hints given us as to the *origin* of the earth's magnetism. It is through the study of the *variations*, then, that we hope some day to be able to attack the problem as to the origin with some degree of success. Until this study has been completed, it is not believed that anything more than mere surmises, such as the magnetic literature contains *in quanto* can be given.

Whether the earth is a magnet like a lodestone or an electromagnet, is another question which can not as yet be definitely answered, though there are various indications that the earth's magnetization partakes of the character of both. Here again the definitive answer depends upon the successful solution of the questions as to the variations of the earth's magnetism both as to time and space.

These introductory paragraphs are intended to emphasize the proposition that if progress is to be made in the subject of the earth's magnetism, we must first make a careful and exhaustive study of the facts which are daily experiences, before attempting broad, theoretical generalizations based on more or less inadequate data permitting at the most mere qualitative tests of the deductions of theory. What are needed are the facts for *quantitative* tests. Even then, it will be found, in some instances, that more than one theory will satisfactorily explain the same facts and that a final decision must be left to future generations. However, the *facts* will remain as a permanent acquisition. *The accumulation of clean-cut facts regarding the earth's magnetism is the great task of the present generation.*

In the hope of enlisting interest in this comparatively unexplored field of scientific inquiry, it will be my endeavor to reveal some of the gaps to be filled as well as to exhibit those facts considered as safely established. It must be remembered that we are working in a field bordering on several other sciences, such as astrophysics, geophysics, geology and meteorology, so that he who wishes to become an expert must have at his command the ability to make the best and most intelligent use of the experimental facts of several of the older, recognized sciences. The physicist now-a-days has no time to attempt to master so special and comprehensive a subject as that of the earth's magnetism, with its manifold ramifications into cognate sciences, for he finds it sufficiently difficult to keep in touch with the rapid advances in his own subject. However, if the physi-

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cist, the mathematician, the geologist or the astrophysicist has presented to him the problems of the earth's magnetism concerning him specially, definite advance along certain lines may be confidently expected. The point then made is that the successful solution of some of the vexing problems of the earth's magnetism, in this day of rapid advances in experimental research, can not be attempted by one individual; he must associate with him experts in several of the older, fundamental sciences and have at his command a staff of computers. It must, hence, be a source of great gratification that this dream has been realized in the establishment by the Carnegie Institution of a Department of International Research in Terrestrial Magnetism, with facilities for adequately and exhaustively collecting, collating, supplementing and discussing magnetic data. With such means, let us hope that before very long we may be able to present a more favorable report on the state of our knowledge regarding the earth's magnetism, than the one which can be given now.

One of the most fundamental inquiries to be made in the discussion of any of the earth's magnetic phenomena, before attempting a theoretical explanation, is as to the *seat* of the forces giving rise to the phenomenon in question. Thus many a theorist might have saved himself some pains had he first addressed himself to this inquiry. To illustrate:

Suppose our first question to be the following: Since we can produce the magnetic phenomena pertaining to the earth's so-called 'permanent' magnetism, observed on the surface, by a system of closed electric currents, where are these currents? Do they circulate around the earth below the surface or in the regions above us? We know, as a fact of common experience, that the end of the needle designated as the north-seeking end, or for short, the north end, points approximately towards the north. Hence, applying Ampere's rule, the electric currents necessary to produce this phenomenon must circulate around the earth from east to west, if they be *inside* the earth, and if they are, on the other hand, *outside* the earth, they must circulate from west to east. To determine where the currents really are we must resort to another well-known phenomenon, viz., that the end of the needle which points to the north dips below the horizon in our hemisphere and points above the horizon in the southern magnetic hemisphere. Applying to this phenomenon Ampere's rule, we shall find that the currents can only circulate from east to west, hence combining this deduction with our previous one, the answer is that the electric currents which are capable of producing the observed magnetic phenomena cited circulate from east to west inside the earth.

Now this is a perfectly simple and obvious application of a fundamental law in electromagnetism, and yet for want of this test many eminent investigators have lost valuable time and even to-day some cases of transgression or omission might be cited. Thus some of the theories of the secular variation suppose that the electric currents causing this variation are situated chiefly outside of the earth. However, according to recent calculations, as based virtually upon the mathematical application of Ampere's rule, it is found that the observed facts can be made to harmonize best with a system of forces situated chiefly inside the earth. [Since the reading of this paper, the calculations reveal the existence of also a minor system of outside currents taking part in the production of the observed secular variation.]

The first one to make a mathematical test of the seat of the earth's magnetic forces, coupled also with an analysis into

spherical harmonic terms to the fourth order, was Gauss, from whose time a new era in magnetic science was ushered in. As the result of his mathematical analysis, it was definitely proved that by far the greatest portion of the earth's permanent magnetism is to be referred to a system of forces inside the earth and, furthermore, that this system possesses a potential. There were thus deduced two great fundamental facts of nature that outweigh in importance all of the speculative theories concerning the 'how and whence' of the earth's magnetism.

Gauss's calculations have been repeated several times with the aid of more complete material by several analysts, one of them being the noted astronomer and mathematician, John Couch Adams; Gauss's deductions have been verified by all of them.

The most elaborate analysis and attempt at perfection of the theory embodied in the Gaussian analysis was that for 1885 by Professor Adolf Schmidt, at present in charge of the Potsdam Magnetic Observatory in succession to the late and lamented Professor Eschenhagen. Schmidt made provision in his equations: (*a*) For the effect of the spheroidal figure of the earth, Gauss having taken a spherical figure, (*b*) for a possible effect due to forces whose seat was outside the earth, and (*c*) for a possible effect not to be referred to an inside or outside potential, but to a system of vertical electric currents passing through the earth's surface, whether from inside or outside.

Schmidt found that about 95 per cent. of the total magnetization of the earth was to be referred to an inside potential and that the remainder was due to a small outside potential and an electric current system traversing the earth perpendicularly to its surface. [The writer has since found that the principal term of the outside potential is displaced about one hundred degrees (100°) to the *west* with reference to the principal term of the inside potential.]

Fritsche in the main verified Schmidt's work, though he did not introduce the refinement due to taking into account the spheroidal figure of the earth, but retained the simpler equations based on the spherical figure.

The writer has recently made a critical comparison of the results thus far obtained by the various analysts, and has derived the differences between the elements as computed upon the basis of the theory and the observed or chart quantities, his purpose being to ascertain wherein further improvement of the theory is needed and what direction promises the best success. The residuals exceed many times the errors of observation.

It would appear that at the present stage very little increased accuracy has been gained by taking into account the spheroidal figure of the earth and that the theory must receive elaboration in other fundamental directions. Thus, for example, suppose the principal portion of the earth's magnetic system to be situated at some considerable depth below the surface—a condition of which we in fact have indications—then the question must be considered as to the effect arising from the magnetic permeabilities of the strata intervening between the seat of the system and the place of measurement of the forces. Instead of having the simple Laplacian equation and, as the result of which, a strictly harmonic distribution of the forces, we may have instead the more generalized equation:

$$\frac{\partial}{\partial x}\left(\mu\frac{\partial V}{\partial x}\right)+\frac{\partial}{\partial y}\left(\mu\frac{\partial V}{\partial y}\right)+\frac{\partial}{\partial z}\left(\mu\frac{\partial V}{\partial z}\right)=0,$$

and in consequence a quasi-harmonic distribution. So that the Gaussian potential expression, based on the simple Laplacian equation, may represent only a first approximation to the truth.

The material for testing this hypothesis, however, is not yet either at hand or sufficiently complete.

And right here we must record a most lamentable condition of our knowledge regarding the general distribution of the earth's magnetic forces. One of the surprising results of my critical comparison, above referred to, was the fact that *the accuracy in the determination of the earth's magnetic potential is about the same whether we use the magnetic charts of Sabine of 1840–5 or the best modern magnetic charts.* In other words, whereas magnetic surveys have steadily progressed on land areas and even have been repeated in certain instances in greater detail, the magnetic survey of the great oceanic areas and of the unexplored land regions has made very little progress during the past half century. The advent of the iron ship has materially lessened the yield of useful magnetic data and the expeditions designed for securing sea results have been unfortunately too few and far between. In the Antarctic regions, for example, practically no progress had been made since the observations of Ross in the *Erebus* and *Terror* during the fourth decade of the last century until the recent Antarctic expeditions of the British and German empires.

Fortunately, however, there is an awakening interest in this direction. Thus a committee has been appointed by the International Association of Academies, at its recent meeting in London, to consider methods for securing increased accuracy in magnetic work at sea. Furthermore, the plans of the Department of Terrestrial Magnetism of the Carnegie Institution embrace cooperation in the magnetic survey of the oceanic areas, and it is confidently hoped that a beginning in this direction can soon be made. Instruments for this purpose have already been ordered. Also, I am glad to be able to announce that, having succeeded in organizing the detailed magnetic survey of the land area of our country, attention has next been paid to inaugurating similar work at sea on the Coast and Geodetic Survey vessels; three of them have already been fully equipped for this purpose and this fall two more will receive their magnetic equipments. While these vessels can only obtain magnetic data incidentally in the course of their surveying work, experience has shown that a very satisfactory degree of accuracy can be secured by their skilled officers. The magnetic declination and dip can be obtained, for example, to about 5′ to 10′ and the total force to about one five-hundredth part.

We next inquire, *is the earth's magnetic energy increasing or decreasing?* This is a question of fundamental importance to theories of the earth's magnetism. As is well known, the earth's magnetic elements are subject to a secular variation whereby considerable changes are produced in the course of time. A secular variation may result from a change in the intensity of the magnetization of the earth, or from a change of the direction of magnetization, or from both causes.

The first term of the Gaussian potential is of a simple harmonic type and constitutes by far the largest term; it represents about 65 to 70 per cent. of the total magnetization and can be physically interpreted as a uniform or homogeneous magnetization symmetrical about a diameter, inclined $11\frac{1}{2}°$ to the earth's axis of rotation. This diameter Gauss defined as the earth's magnetic axis, with respect to which he determined the magnetic moment due to the first term. Tabulating the values of the magnetic moment as derived for different epochs from the various analyses, we shall find that it has decreased in forty-six years by 1.6 per cent.—an alarming loss, if true!

The question now is, whether this apparent loss is in any way wholly or partially compensated for by a possible increase in magnetic energy of the portion of the earth's magnetism represented by the remaining terms of the Gaussian potential, *i. e.*, by the portion which can not be referred to a uniform magnetization about some diameter? If mutual compensation does not take place, what is the annual loss of the earth's total magnetization?

To answer this query, I have made use of the well-known function in physics giving the energy W, of a distribution of forces in terms of the field intensity, F, viz.:

$$W=\frac{1}{8\pi}\int \mu F^2 d\tau$$
$$=\frac{1}{8\pi}\iiint \mu(X^2+Y^2+Z^2)dxdydz,$$

where μ is the magnetic permeability and $d\tau$ is the element of volume and X, Y, Z are the rectangular components of F. The integral is confined to the space outside of earth, so that we may take μ as a constant and set it equal to 1. We may also give the expression the following form:

$$W=-\frac{R^2}{8\pi}\int VZds.$$

Here V is the magnetic potential and Z the vertical force on the earth's surface, R the earth's mean radius and ds the element of surface. As a check I have made some of the calculations with both forms and have gotten, of course, identical results.

The following table gives the values of the magnetic energy as derived for the various epochs and as dependent upon the best of the analyses thus far made:

Table I. Values of the Earth's Total Magnetic Energy in C. G. S. Units (Ergs).
(The tabular numbers are to be multiplied by the cube of the Earth's mean radius.)

No.	Computer of Potential.	Epoch.	I.	II.	III.	IV.	II + III + IV.	Total.
1	Erman-Peterson.....	1829	.03562	.00026	.00015	.00004	.00045	.03607
3 and 6	Adams.	1842.5	3590	29	15	3	47	3637
4	Fritsche	1842.5	3614	28	14	3	45	3659
8	Adams	1880	3481	36	17	4	57	3538
9	Fritsche	1885	3472	34	15	4	53	3525
5 and 11	Neumayer-Petersen..	1885	3464	35	16	4	55	3519
10 and 13	Schmidt	1885	3494	34	15	4	53	3548
	Mean of first three...	1838	.03589				.00046	.03635
	Mean of last four....	1884	3478				54	3532
	Change in.....	46 years	—.00111				+.00008	—.00103

Hence we have for

	Earth's Total Magnetic Energy.
1838	0.03635 R^5 Ergs
1884	0.03532 R^5 Ergs

or a loss of 0.00103 R^5, or 2.88 per cent., or about one thirty-fifth part in forty-six years. This result is a startling one, for, if true and if the loss in the earth's magnetization continued at the same rate as prevailed during the period 1842–1885, it would imply that the earth will have lost its magnetic energy in about 1,600 years; hence extreme caution should be employed before reaching a definite conclusion. I have made some attempt to ascertain whether this loss can be accounted for by the difference in the material used in the construction of the various charts, and while it would appear that the loss is greater than the effect due to the difference of material, I am unwilling at present to announce a definite conclusion, but think it best to leave this question, at present, open.

Allusion was made above to the *possible*

existence of vertical electric currents passing through the earth's crust, as revealed by Schmidt's analysis. He found that there was on the average for the entire earth, for every square kilometer of surface, a current of one sixth of ampere, passing perpendicularly through the surface, either from the air into the earth or *vice versa.* However, as certain investigators found it difficult to harmonize a current of this strength with the known phenomena of atmospheric electricity, and since similar investigations conducted over well-surveyed, though restricted, areas by several eminent magnetists did not reveal these currents, Schmidt was led to doubt his result and ascribe it to systematic map errors.

The existence of these currents is revealed by the non-vanishing of the line integral of the magnetic force taken around a closed curve on the earth's surface. Such line integrals serve as a test of the hypothesis of a potential, as was first shown and approximately applied by Gauss. Let us choose, as our circuit, a parallel of latitude, and let us call, as is customary, the component of the horizontal magnetic force resolved in a west-east direction, the Y component, then, if $d\lambda$ is the element of the parallel,

$$\int_0^{2\pi} Y d\lambda = 0,$$

if the earth's entire magnetic force is due to a potential. If, on the other hand, electric currents of the kind mentioned exist, then, if I represents the total amount of electricity passing per second of time through the zone from the north geographical pole down to the parallel around which the circuit is made, expressed in electromagnetic units, we have:

$$I = \frac{1}{4\pi} \int_0^{2\pi} Y d\lambda.$$

In a paper published in 1897 I computed the values of I for every fifth parallel from 60° N. to 60° S. as based on Neumayer's magnetic charts for 1885, and also gave a graphical representation along a meridian of the average distribution of the currents found. The resulting system was such a methodical one as to strongly suggest that there might be some truth, after all, in the existence of vertical earth-air electric currents.

With the aid of the facilities of the Department of Terrestrial Magnetism of the Carnegie Institution, I recently have had my calculations for 1885 repeated for two other epochs, viz., first, as based upon Sabine's magnetic charts for 1840–5, which depended upon magnetic data distributed over about seven decades, with the date 1840–5 about in the middle of the series and secondly, as based upon Creak's charts for 1880 issued just after the magnetic results of the *Challenger* expedition were available to him.

A further check upon the computations was obtained by a consideration of the magnetic declination charts alone, viz., for four epochs—Sabine (1840–45), British Admiralty (1858), Creak (1880) and Neumayer (1885). The calculations were based on the following principle: the downward electric currents will deflect the north end of a magnetic needle to the west, whereas the upward currents will deflect the north end to the east. The results obtained thus, agreed well with that obtained from the Y components.

The mean results as derived from all the computations are given in the table on the following page.

For example, through the region of the earth between the parallels 50° north and the equator, the resultant quantity of electricity passing every second of time from the air into the earth amounts to 419×10^4 amperes. In the zone between the two parallels 50° N. and 40° N., the resultant currents are upward and the total amount

TABLE II. VERTICAL EARTH-AIR ELECTRIC CURRENTS.

[Plus sign means upward currents; whereas minus sign implies downward currents.]

Zone.	I in 10^4 A.	i in A per sq. km.
50 N. to Equator	—419	
40 N. to Equator	—539	
30 N. to Equator	—544	
20 N. to Equator	—313	
10 N. to Equator	— 90	
Equator to 10 S.	+105	
Equator to 20 S.	+203	
Equator to 30 S.	— 9	
Equator to 40 S.	— 86	
50 N. to 40 N.	+120	+.038
40 N. to 30 N.	+ 5	+.001
30 N. to 20 N.	—231	—.057
20 N. to 10 N.	—223	—.052
10 N. to Equator	— 90	—.020
Equator to 10 S.	+105	+.024
10 S. to 20 S.	+ 98	+.023
20 S. to 30 S.	—212	—.053
30 S. to 40 S.	— 77	—.021

of electricity passing per second of time from the earth to the air is 120×10^4 amperes; dividing the latter quantity by the total area of the zone, the upward current is found to average for the zone 40 N. to 50 N., 0.038 ampere per square kilometer. The quantities i in the last column give a maximum downward current in the zones 20 N. to 30 N. and 20 S. to 30 S., and upward currents near the equatorial belts, and again beyond parallels 30°.

The general conclusion to be drawn appears to be:

All of the modern magnetic charts—i. e., since those of Sabine for 1840–5—unite in indicating the probable existence of vertical earth-air electric currents of the average intensity over the region 45° N. to 45° S. of one thirtieth of an ampere per square kilometer of surface. These currents of positive electricity proceed upward (from the earth into the air) near the equatorial regions where there are ascending air currents, and downward near the parallels 25° to 30°, i. e., in the regions of descending air currents. Near the parallels 40° the electric currents are again upward, thus corresponding once more with the general atmospheric circulation. Beyond the parallels 45° the results appear too uncertain to warrant drawing a definite conclusion.

If it be true that the vertical electric currents are to be associated with air currents, and are hence convection currents, the importance of choosing circuits for testing the validity of the potential hypothesis in localities of steady air currents is made manifest. It is thus clear that meteorological conditions may play an important part—as already pointed out in my 1897 paper—in investigations as to the existence of vertical electric currents from magnetic surveys over limited areas.

In order to make some tests as to the manner of distribution of the upward and downward electric currents, the currents over quadrilaterals bounded by two parallels 10° apart and two meridians, likewise 10° apart, have been derived for the entire region from 60° N. to 60° S., for the three epochs 1842, 1880 and 1885. As a general result, it did not appear as though the directions of the electric currents—whether up or down—were to be associated with the distribution of land and water. There was, however, a decided indication, *for each epoch*, that over the areas of low pressure, where the air-currents are upward, there the electric currents were likewise, in general, upward, and that over the areas of high pressure where there are descending air-currents, there the electric currents were likewise descending.

Thus, as the average result, from the three epochs we have:

Region.		Quantity of Electricity
60° N. to 60° S.	for areas of low pressure:	$+829 \times 10^4$ amperes
	" " " high " :	-638×10^4 "

(+ means upward electric currents; —, downward electric currents.)

The average effect of electric currents for the region 45° N. to 45° S. is on the

east-west component of the earth's magnetic force (Y), 0.001 C.G.S. unit, or about one fiftieth of the average value of Y. The average effect on the horizontal intensity is about one one-thousandth part, *i. e.*, on the order of the error of a field determination. However, the average effect on the declination is about 0.2°—about six times the error of a reduced field determination of the declination on land, and about one to two times the error of a determination at sea by the most approved methods.

Having given the results to be deduced from a mathematical analysis of the earth's permanent magnetic field in accordance with the principles laid down by Gauss, let us now briefly turn our attention to another *mode of attack with the purpose of deriving physical interpretations of the various harmonic terms entering into the Gaussian expression.* The general title of the series of the papers devoted to this subject, of which the fourth number appeared in the September issue of the journal *Terrestrial Magnetism and Atmospheric Electricity,* is 'The Physical Decomposition of the Earth's Permanent Magnetic Field.'

The first harmonic finds a ready physical interpretation: it represents that entire portion of the earth's total magnetization which can be referred to a uniform homogeneous magnetization of the earth about a diameter inclined to the axis of rotation. This term represents about 65–70 per cent. of the total field. Let us term it the primary or 'normal' field.

The diameter or axis of magnetization of this field for 1885 made an angle of 11° 25.7′ with the rotation axis and pierced the northern hemisphere in longitude 68° 30.6′ W. of Greenwich. Its magnetic moment was 0.32298 R^3, C.G.S. units, R being the earth's mean radius. These figures were dependent on Schmidt's analysis of the earth's permanent magnetism, and a slight revision would be required in accordance with his latest published Gaussian coefficients. However, as it was found that these slight revisions are on the order of error of determination, it will, therefore, not be worth while at present to make any change.

In No. II. of the series of papers alluded to, it was shown how the determinations of the magnetic axis and of the magnetic moment were dependent upon the portion of the earth considered in the calculations, so that strictly the quantities adopted apply only to the area embraced. Fortunately, however, the effect of the neglected portions of the earth—the polar regions—diminishes rapidly with advancing latitude, so that the values as adopted for the primary field, depending as they did upon data from 60° N. to 60° S., will not differ sufficiently from those obtained, had there been data over the entire globe, to vitiate the general deductions regarding the characteristics of the 'residual' or 'secondary field,' *i. e.*, that portion of the earth's total magnetization remaining after deducting the homogeneous magnetization (the first term).

The map of this residual field has now been constructed for three epochs; first, for 1885 and recently also for 1842 and 1880, the first depending on Neumayer's magnetic charts for 1885, the second on Sabine's charts and the third upon Creak's charts. The maps of the residual field for the first two epochs agree well in all the principal features with the one for 1885.

The residual magnetization can thus be broadly characterized: it consists chiefly of two main magnetizations transverse to the axis of rotation, one system lying in the northern hemisphere, the north end attracting pole (N_1) being east of the south end attracting poles (S_1', S_1''), and the other in the southern hemisphere, the direction of magnetization being the reverse

of the former, the north pole (N_2) lying now west of the south pole (S_2). The poles of the two systems are situated, approximately, near the 40° parallels—this is even true of the tertiary system N_3S_3.

The secondary magnetic equators (the lines along which the residual vertical force is zero) occupy practically the same positions for the three epochs. It is as yet too early to decide as to any probable secular shifting of the positions of the secondary poles. The interval is too short, in view of the meagerness of the data on which the charts depend, to make certain any deductions.

What has thus far been gained by the decomposition of the earth's total magnetic field into a primary and into a secondary one?

In the first place, the residual field clearly exhibits the fact that it is not a heterogeneous one, but, in general, remarkably systematic in its structure. There is, therefore, a very strong indication that it is produced by some distinct physical cause operating in the same general manner over the entire earth. The hope is thus clearly held out that we may still further resolve the residual field, starting with fundamental, physical causes.

My present belief is that the chief physical cause of the residual field is to be referred to the distribution of temperature within the stratum of the earth's crust here concerned.

There is a very remarkable correspondence between the principal features of the residual magnetic field and those exhibited on a chart of isabnormal temperatures. It is found that the earth as a magnet acts like any other magnet as regards application of heat. Thus, wherever the earth's surface is relatively warm, on the average for the year, there the magnetization of the earth shows a decrease, and where, on the other hand, it is relatively cold, there it suffers an increase. The comparison held so far, that it is possible to reproduce the residual magnetic field, in its general characteristics, with the aid of temperature charts.

The criticism has been made that this relation between residual magnetism and temperature distribution may only be an apparent one, since the latter referred to surface conditions, whereas the former pertained to strata at considerable depths below the surface. However, the isabnormal temperatures plotted were based on annual means; hence the effects due to annual variation and diurnal variation were eliminated. I am not aware that any one has given a physical explanation of the situations of the maxima and minima shown on an annual isanomalous temperature chart. Their annual positions are probably largely dependent on the radiation of the internal heat of the earth. We can not say, as yet, at what depth the principal thermal features shown at the surface are eliminated; it is known that the isothermal surfaces in the interior conform with those of the surface to a considerable depth. In any case, there is no question that as land areas are pierced, a steady increase of temperature is encountered. Over oceanic areas, on the other hand, there is at first a decrease until nearly a zero temperature is reached at the ocean beds, and then, presumably, an increase as the penetration continues. So that we shall have temperature gradients along parallels of latitude down to a considerable depth.

I shall not discuss this matter further now, as it is being made the subject of a special examination. Many have surmised that the distortion of the earth's magnetic field is to be attributed to the distribution of land and water; but the problem is to show in what manner the distribution causes the observed effects. The first attempt, as stated, will be to ascertain whether

the cause is to be sought in the distribution of temperature in the upper stratum of the earth's crust, as produced largely by the distribution of land and water. *The results of the decomposition have thus revealed one promising mode of attack of the problem as to the causes of the asymmetrical distribution of the earth's magnetism.*

Another extremely interesting result is that a very close similarity is found to exist between the chart of the residual permanent magnetic field and that of the system of forces causing the diurnal variation of the earth's magnetism. The two magnetic systems are identical in their general characteristics except in one respect, viz., the first is to be referred to a system of magnetic forces in the earth's interior, whereas the second to a system outside, the relative positions of the poles being governed accordingly. Thus at Greenwich mean noon, for example, the north end attracting pole of the first system would be about vertically below the south end attracting pole of the second system, and the south end attracting pole of the first would be about directly below the north end attracting pole of the second system—this statement holds for the main transverse magnetization in each hemisphere.

There appears to be more than a chance connection in this relation, as is shown by the horizontal vector diagrams for various parallels as resulting from the two respective fields.

I have had the impression for some time that the earth's permanent magnetic field may play a very important part in the production of the diurnal variation field as observed on the earth's surface. No satisfactory explanation has as yet been given of the manner in which the peculiar magnetic system of forces causing the diurnal variation is actually produced. Schuster's first attempt at the construction of the equipotential lines of the diurnal variation field, based as it was on exceedingly meager data, was, nevertheless, remarkably correct in its general features, as shown by the recent more elaborate work of Fritsche. We, therefore, have now a fairly accurate map of this field.

The existence of some form of radiation from the sun which does not penetrate to the lowest strata of our atmosphere, and which is yet capable of deflecting magnetic needles on the earth's surface, appears to have been definitely proved by the recent magnetic observations during solar eclipses. It was, furthermore, shown that the eclipse magnetic variation was a phenomenon similar to the diurnal variation, and that it differed from the latter only in degree; the ranges in the declination variations, for example, were proportional to the amounts of radiation cut off by the respective bodies: the moon and the earth.

It is known how a moving electrified particle will be deflected by a magnetic field, and how, in general, it will be made to travel in a spiral path whose axis is the line of magnetic force. Is it possible now, that as a result of the combined action of the permanent magnetic field of the rotating earth and the electrified particles radiated by the sun, there is formed in the regions above us a secondary magnetic system precisely similar to that of the earth?

The physical analysis of the permanent field, in addition to furnishing a number of interesting results, thus leads us, in a seductive manner, to the consideration of forces and phenomena not hitherto associated with those of the permanent magnetic field. We are led to inquire as to the rôle played, in the economy of nature, by the magnetic energy stored up in the regions outside, due to the earth's permanent magnetic field, in preventing certain solar radiations from reaching the lower

strata of our atmosphere. And at this threshold it will be well for us to pause and defer further exploration to a future time.

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SCIENTIFIC BOOKS.

Educational Psychology. By Edward L. Thorndike, adjunct professor of genetic psychology in Teachers College, Columbia University. New York, Lemcke and Buechner. 1903. 173 pp.

This book 'attempts to apply to a number of educational problems the methods of exact science' and to place at the service of students the incoherent mass of psychological knowledge which constitutes 'the beginnings of what we may call a general dynamic psychology.' That the facts already known "have thus far gone without systematic and convenient exposition is due to the complexity of the problems involved, not to any doubt concerning their practical importance. What we think and what we do about education is certainly influenced by our opinions about such matters as individual differences in children, inborn traits, heredity, sex differences, the specialization of mental abilities, their interrelations, the relation between them and physical endowments, normal mental growth, its periodicities, and the method of action and relative importance of various environmental influences." These then are the topics with which the book is concerned.

The first chapters deal with the measurement of mental traits. They explain the statistical principles by which we can apply exact measurements to groups of variable objects taken as a whole, and then proceed to show that in the matter of mental traits, as of physical, human beings of the same sex and approximately the same race, age and experience constitute a true group—that for every mental trait there is a mean or 'center of gravity' from which slight variations are frequent and great variations rare, according to the law of the distribution of chance events; so that measurements in terms of percentile grades or other relative standing can be interpreted fairly accurately in terms of absolute amount, and causal agencies acting unequally on different parts of the group can be detected by the analysis of curves of distribution.

In the fourth chapter the author explains the statistical principles by which we can measure the correlation between different characteristics in a group of individuals, and then applies Pearson's coefficient to show that in the matter of mental traits this correlation is amazingly small. This means that within a given group of individuals goodness or badness in one psychological function (as shown by school grades or the results of special tests) is not particularly likely to be accompanied by a similar amount of goodness or badness in another, even though the two appear to be only slightly different. If any one is disposed to deny this, let him first go over the large amount of evidence (much of it based on his own incessant investigations) which Dr. Thorndike puts together in this chapter.

Ever since the appearance of Professor James's chapter on memory the doctrine of general mental functions which can be cultivated by appropriate exercise and then turned to any use (a survival of the old 'faculty' psychology) has been more and more discredited amongst psychologists, though college presidents still make use of it to proclaim their wares and teachers in the public schools have never dreamed of anything else. But this doctrine can not be reconciled with the small coefficients of correlation shown in chapter IV. If there is such a thing as training or neglecting 'the memory' we should expect to find goodness or badness in remembering words accompanied by something like the same amount of goodness or badness in remembering numbers, to say nothing of colors, forms and tastes. But as a matter of fact the correlation is 'slight and variable'; and so with other functions.

In chapter VIII., on 'The Influence of Special Forms of Training upon More General Abilities,' the author presents evidence bearing still more directly upon this important educational doctrine, and gives a powerful argument to those who would adapt school

programs to the needs of life as directly as possible. If successful practise in guessing the size of paper squares less than four inches long gives relatively little improvement in the ability to guess the size of squares a trifle larger; if practise in marking all the words on a page which contain two given letters is very effective so far as these two letters are concerned, but gives only one third as much increase of speed for marking other letters, and still less increase of accuracy (in some cases accuracy in one function was actually diminished by the practise which increased it for a similar function); and if such improvement as there is can be accounted for by the overlapping of absolutely identical elements in the very closely allied activities tested; if, in short, there is practically no such thing as accuracy or thoroughness or concentration in general any more than there is memory or reasoning power in general, but only an unlimited number of relatively independent mental reactions, then the college president must cease promising, much like Protagoras of old, to give the young man or woman who comes to him 'a better disciplined mind for whatever work in life he may turn his attention to,' and the schoolmaster who wishes to give his pupils a 'well-rounded' education must learn to define the rotundity in terms of something other than a 'symmetrical development of faculties,' and not attach too much importance to so-called 'disciplinary' studies. *A propos* of these, it is interesting to notice that efficiency in mathematics bears no more relation to a schoolboy's general standing than does efficiency in any one of several other studies, and not so much as efficiency in English. Indeed, tests show that there is not much correlation between efficiency in two different mathematical studies, or even between two different processes in arithmetic; so great is the specialization of mental functions!

The chapter on the Inheritance of Mental Traits clears away theoretical objections to the possibility of such a thing and then shows by statistics, taken largely, though not altogether, from Galton and Pearson) that the influence of heredity is tremendous, though such evidence as is available points decidedly against the inheritance of acquired characteristics. "Original nature springs from original nature. Its improvement depends on the elimination of the worse, not on their reformation"; and yet "A college president can get hundreds of thousands of dollars to teach men various accomplishments, but he would be laughed at if he asked for $10,000 to prevent the most gifted young man in the college from remaining childless until 35."

The chapters on the relations of mental traits to age, sex and physical peculiarities are hard to summarize. They contain considerable positive material, but, like the chapter on Broader Studies of Human Nature, their main function is critical. They direct attention to unsolved problems, suggest methods of inquiry, and point out the errors by which various investigations have been vitiated; thus reminding us that, after all, we have only 'the beginnings' of a dynamic psychology.

Some such work as this of Thorndike's has been sadly needed. If the methods that it explains are all familiar to statisticians they are certainly unknown to many psychological investigators who deal with statistics, and if the criticism to which it subjects much work already done is pitiless, it is honest and fearless, and the constant expositions of method leave no excuse for slipshod work in the future.

As a text-book for students this 'Educational Psychology' can be used with great success. To be sure, it does not raise the reader to the heavens in a cloud of soul-stirring generalities, and there are some students who find many statistics somewhat overwhelming and frequent negative conclusions discouraging. But for students as well as for teachers of education it is worth while to know exactly where we stand and how great our ignorance often is; and those who have read the book and taken the trouble to master it appreciate its scientific spirit and its fiber.

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SOME RECENT LITERATURE ON THE STONY CORALS AND A REVIEW OF 'STEINKORALLEN' VON DR. EMIL VON MARENZELLER.*

During the time that has elapsed since the beginning of 1902, students of the *Madreporaria* have shown an unusual activity, and quite a number of very valuable papers, approaching the group from various sides, have been published. A few of the most important will be mentioned. Dealing with fossil corals there are, Lebedew's 'Die Bedeutung der Korallen in den devonischen Ablagerungen Russlands,'† Felix's splendid work on 'The Cretaceous Corals of the Gosau,'‡ and many shorter papers. During this period Duerden has published the results of his elaborate investigations on the 'West Indian Madreporarian Polyps."§ Verrill is the author of several interesting memoirs on West Indian, Bermudan and Brazilian corals,|| and 'Notes on Corals of the Genus *Acropora*.'¶ Gardiner has published 'South African Corals of the Genus *Flabellum*'** and Parts I. and II. of his '*Madreporaria*' of the Maldive and Laccadive Archipelagoes.†† Döderlein has published an excellent memoir on the genus '*Fungia*.'‡‡ Bernard has given us a most painstaking and elaborate monograph on the genus *Goniopora*.§§ We are indebted to Alcock for an excellent paper on the 'Deep-Sea *Madreporaria* of the Siboga Expedition.'* Besides these longer contributions on recent corals, a large number of shorter ones have appeared.

Never before have the *Madreporaria* received so much earnest attention. The group is being studied in almost every conceivable way by able investigators. The standard of excellence that prevails in these modern contributions is very high, it probably has not been excelled. But before the ultimate goal is attained, *i. e.*, the understanding of the relation of the organisms to their environment, the unraveling of the geologic history of the group and the formulation of a classification along philogenetic lines—much more work must be done. However, the outlook was at no previous time so bright as it is now. The one side that most demands attention is that of experimental physiological work—experimental study of the effects of environment on variation. These problems could be taken up by some of the marine laboratories. Probably much could be done by the Carnegie Laboratory on the Dry Tortugas.

Another valuable paper, Dr. von Marenzeller's 'Steinkorallen' of the *Valdivia* expedition, has just come into my hands.

The *Valdivia* obtained with 33 hauls of the dredge 29 species of stony corals. The depth varied from 44 to 2,278 meters; in only eight cases was it greater than 900 meters; in two cases it was less than 100.

There were six stations in the Atlantic Ocean, distributed from the west coast of Scotland to the Cape of Good Hope. The other stations are divided into five groups:

I. Cape Angulhas and Angulhas Bank, southern Africa.
II. Bouvet Island, Lat. 54° 29′ 3″ S., Long. 6° 14′ E.
III. Islands of St. Paul and New Amsterdam, in the southern Indian Ocean.
IV. West of Sumatra.
V. From Dar-es-Salam northward along the eastern coast of Africa.

It will thus be seen that the collections were made in the Atlantic and Indian oceans.

* *Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition* auf dem Dampfer *Valdivia*, 1898–1899, Bd. VII., pp. 261–318, Taf. xiv–xviii, 1904.

† 'Mem. Comité Geology.,' St. Petersburg, Vol. XVII., No. 2, pp. ix, 1–180, 5 pls., 1902.

‡ 'Die Anthozoen der Gosauschichten in den Ostalpen,' *Palæontographica*, Bd. xlix, pp. 163–360, 19 Taf., 1903.

§ 'Mem. Nat. Acad. Sci.,' Washington, Vol. VIII., pp. 399–597, 25 plates, 18 figs., 1902.

|| *Trans. Conn. Acad. Sci.*, Vol. XI., pp. 63–206, 26 pls., 1902.

¶ *Ibid.*, pp. 207–266, 7 pls., 1902.

** 'Marine Investigations in S. Africa,' Vol. II., No. 6, pp. 113–154, 4 pls., 1902.

†† Reviewed in this Journal, Oct. 14, 1904.

‡‡ 'Die Korallengattung Fungia,' *Senckenberg. Naturfors. Gesellsch.*, Bd., XXVII., Heft I., pp. i–iv, 1–162, 25 Taf., 1902.

§§ 'Brit. Mus. (Nat. Hist.) Cat. Madreporarian Corals,' Vol. IV., pp. i–viii, 1–206, 14 pls., 1903.

* 'Siboga-Expeditie,' Mon. xvia, pp. 1–51, 5 pls., 1902.

The Bouvet Island locality is considered especially interesting because it lies so far south and connects with the Antarctic Madreporarian fauna. One species, *Caryophyllia antarctica* n. sp., was found there.

After the remarks concerning the areas from which the corals were obtained, are: 'List of the stations at which *Madreporaria* were collected,' for each station the latitude and longitude, depth, an occasional remark on the character of the bottom, and the species found there are given; 'The depth at which the *Madreporaria* occurred,' the species are listed according to the depth at which they were found; 'List of the species,' each species named being followed by the appropriate station numbers.

Then a detailed consideration of the species is given. The following is a list of the genera, with the number of species referred to each and the names of those described as new:

Desmophyllum, 1; *Flabellum*, 7, *F. deludens* nov., *F. stabile* nov., *F. chunii* nov., *F. magnificum* nov., *F. inconstans* nov.; *Sphenotrochus*, 1, *S. aurantiacus* nov.; *Deltocyathus*, 1; *Caryophyllia*, 5, *C. antarctica* nov.; *Stenocyathus*, 1; *Aulocyathus* gen. nov., 1, *A. juvenescens*, nov.; *Ceratotrochus*, 1, *C. delicatus* nov.; *Stephanotrochus*, 2, *S. campaniformis* nov., *S. explanans* nov.; *Lophohelia*, 1; *Amphihelia*, 1; *Solenosmilia*, 1; *Parasmilia*, 1; *Bathyactis*, 1; *Balanophyllia*, 1; *Dendrophyllia*, 1; *Coenopsammia*, 1; *Anisopsammia* gen. nov., 1.

The new genus *Aulocyathus* resembles *Schizocyathus* Pourtalès in external appearance; each of the four of von Marenzeller's specimens was attached to the inner side of a fragment of the same species. It is a member of Duncan's *Trochocyathoida* and because of the absence of pali belongs in a group with *Ceratotrochus*.

The genus *Anisopsammia* is proposed for the *Amphihelia* (subsequently, ? *Stereopsammia*) *rostrata* of Pourtalès. This genus is separated from *Coenopsammia* by having the calices on one side of the corallum, facing one way. I consider the genus of very doubtful value, being inclined to the opinion of Pourtalès that his *Dendrophyllia profunda* and ? *Stereopsammia rostrata* are congeneric.

One of von Marenzeller's generic names must be changed. Professor Verrill* has shown that *Madrepora oculata* Linn. = *Amphelia* or *Amphihelia oculata* of nearly all authors from Milne Edwards and Haime to the present time, must become the type species of the Linnaean *Madrepora*. This is an extremely inconvenient change, but unless we throw over entirely our rules of nomenclature it must be made.

The validity of a few of the species is doubtful.

The five plates that illustrate the paper are very good.

This is an excellent paper and the criticisms are of a minor nature. It supplements the work that Alcock has been doing on the deep-sea fauna of the Indian Ocean and on that around the Dutch East Indies. I have practically completed a report on the deep-sea corals dredged by the United States Fish Commission around the Hawaiian Islands and the illustrations are far advanced. The Hawaiian fauna, although it contains quite a number of new things, bears very considerable resemblance to that of the East Indies and the Indian Ocean. The Fish Commission collections will make an important addition to the Indo-Pacific faunas.

There are in our United States National Museum considerable collections of deep-sea corals dredged off the western coast of America. These should be studied in connection with the general subject of Indo-Pacific deep-sea faunas, to which Moseley, Alcock and von Marenzeller have already made contributions of so much value. It is my hope that before a great while I shall be able to present a suitable report on these portions of our unstudied collections.

T. WAYLAND VAUGHAN.
SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.,
October 19, 1904.

* *Trans. Conn. Acad. Sci.*, Vol. XI., pp. 110–113, 1902.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES, SECTION OF BIOLOGY.

THE meeting of October 10 was devoted to reports on summer work by members. In the absence of Professor Underwood, Professor Sumner was elected temporary chairman. The members reported as follows: Professor E. B. Wilson worked at the Naples, Sorbonne and Roscoff laboratories, continuing his studies of germinal localization in mollusks. Professor Bashford Dean attended the zoological congress at Berne and the British Association meeting in Cambridge, and later visited places of scientific interest in France. Professor Bristol worked at the Bermuda Biological Station, of which he was one of the directors. Mr. Yatsu worked at the Tufts College laboratory in Maine. Mr. Kellicott worked at the Cedar Point laboratory, in Ohio, completing his studies of the development of the vascular system of *Ceratodus*. Dr. Dublin continued his studies of germ-cells at the Cold Springs Harbor laboratory. Dr. Townsend superintended the remodeling of the water-supply apparatus at the New York Aquarium. Mr. Bigelow conducted special courses for teachers in the summer school of Columbia University. Professor Sumner directed the laboratories and the biological surveys of the Bureau of Fisheries at Woods Hole.

M. A. BIGELOW,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE EARLIEST MENTION OF FOSSIL FISHES.

FOR the satisfaction of those interested in verifying a disputed reference of high antiquity, one, too, which possesses the distinction of including the first mention of fossil fishes in literature, it may be profitable to indicate the source of Dr. Emmons's statement in regard to 'Origines,' briefly noticed in two articles that have appeared in SCIENCE (Nos. 502, 508) under the caption of 'Variæ Auctoritatis.'

Dr. Emmons has been good enough to inform the writer that the authority upon which he relied for the remarks in question was the abridged translation of von Zittel's 'History of Geology and Paleontology.' The German edition of this work briefly summarizes the opinions of Xenophanes on fossils '*as reported by Origen*,' the learned third-century theologian. But here endeth not the first lesson, since there is no doubt that the lamented paleontologist was mistaken as to the author who has preserved for us the views of the enlightened Eleatic.

None of the writings of Origen contains the fragment of Xenophanes which treats of the nature of fossils, but we must turn for it instead to the '*Philosophumena*' (or 'Refutation of all Heresies,' i., 14) of Hippolytus, Bishop of Portus, a voluminous third century writer, and the first great scholar of the Roman church.* The rescue of this valuable work from oblivion through the discovery of a medieval manuscript at Mt. Athos, its publication at Oxford in 1851 under the guise of a continuation of Origen, and subsequent determination of its true authorship, constitute an interesting chapter in the history of paleography.

The scientific fragments of Xenophanes and various pre-Socratic authors have been conveniently brought together, with copious annotations, in the works of Hermann Diels,† Paul Tannery,‡ Mullach and others, and are briefly discussed in the first volume of Zeller's 'Philosophy of the Greeks.' None of these fragments, however, can compensate the loss of the historical compendium drawn up by Theophrastus, which contained abstracts of the scientific views in vogue prior to the Alexandrian age, and is known to us (save

* Concerning Origen and Hippolytus one may consult Schaff's 'History of the Christian Church,' Vol. II. (New York, 1883). Their writings have been extensively published in this country and abroad.

† 'Doxographi Græci' (Berlin, 1879). *Idem*, 'Die Fragmente der Vor-Sokratiker, Griechisch und Deutsch' (Berlin, 1903).

‡ 'Pour l'Histoire de la Science Hellène, de Thalès à Empédocle' (Paris, 1887). The appendix contains a translation of the important treatise by Theophrastus 'On the Sensations.' Additional references are given in the bibliography of Osborn's excellent conspectus, 'From the Greeks to Darwin' (New York, 1894).

for the 'Sensations') only through later compilations.

At the risk of appearing tedious in a matter which is by no means of trivial importance, namely, that of accuracy of citation, we may direct attention to the following pertinent comments taken from the introduction to Tannery's work above referred to:

Combien de fois voit-on de nos jours des érudits, et des plus consciencieux, citer telle page et telle ligne d'un volume qu'ils n'ont jamais eu entre leurs mains! C'est la conséquence forcée du système de citations à la mode, et qui, indispensable pour certains ouvrages, n'en est pas moins inutile et, par suite, abusif la plupart du temps. Il y a là un étalage d'érudition aussi facile qu'illusoire; qui s'est donné la peine de vérifier, par exemple, cent citations de suite dans tel ouvrage moderne, même des plus justement renommés, peut savoir seul combien il a chance d'en trouver d'inexactes ou de complètement fausses sur cent autres au hasard.

Then follow these two excellent prescriptions:

(1) Ne jamais citer avec précision un travail sans l'avoir lu intégralement; (2) se borner à l'indispensable, c'est-à-dire aux seuls cas où l'on peut désirer que le lecteur, pour être mieux convaincu, ait effectivement recours à l'ouvrage invoqué.

C. R. EASTMAN.

HARVARD UNIVERSITY.

POSTSCRIPT.

Through the courtesy of the Editor of SCIENCE it is possible to append a word to the foregoing after proof had already been passed for press. In the issue of SCIENCE for October 21, Dr. Emmons suggests that remarks of mine with reference to him in an earlier article (No. 502) 'seem to flavor of a certain disingenuousness.' This may be construed as implying that the article was contributed subsequently to an exchange of personal letters, in which Dr. Emmons courteously disclosed his authority.

In point of fact this assumption, or implied assumption, is incorrect, my former article having been already in train of publication at the time our correspondence took place. Before it was actually printed there was opportunity to be sure, for certain alterations to be made in the proof, incorporating the later information obtained from Dr. Emmons. But having in the meantime taken pains to verify *his* authority, and finding that von Zittel too was in error, it seemed best to leave the original text unchanged, and bring up the matter afresh on some future occasion; and had this intention been carried out earlier, it is probable that our esteemed Washington colleague would have no grounds for misapprehension.

C. R. E.

October 22, 1904.

PALÆONTOLOGIA UNIVERSALIS.

THE writer desires to call the attention of American geologists to the fact that this very important work has but 21 subscribers in the United States, while France has 63 and Germany 96. Certainly the geologists and geological libraries of this country are not yet supplied with this publication. Fasciculi I. and II. have been issued; these contain 97 sheets redescribing and refiguring 46 of the old and little known species. It is intended to issue annually from 150 to 160 sheets, treating of about 80 species. The annual subscription price is $8.00. Subscriptions may be sent to G. E. Stechert, No. 9 East Sixteenth Street, New York City. Those persons or institutions desiring further information regarding this work, with samples of the plates, will be supplied on application to Professor Charles Schuchert, Yale University Museum, New Haven, Conn.

CHARLES SCHUCHERT.

A PROPOSED GEOGRAPHIC DICTIONARY.

THE increase in interest and the clearer understanding of the origin of many topographic features have caused a great increase in the number of what may be called technical topographic terms during the past twenty years. Further travel and study along geographic lines in foreign countries have led to the gradual adoption by us of many foreign topographic terms for various forms of relief. This growing body of terms is at present scattered through a large mass of literature, usually inaccessible to most students. The present writer's experience has shown very clearly the need for some authoritative dictionary of topographic terms which shall bring together not only the less well known terms, but also those which are now in frequent but very loose use. To meet this need he began

four years ago to compile a dictionary which should in some way serve, not only to fill the wants just pointed out, but also as a guide to appropriate names for new forms. A further use for such a list is suggested by a foreign term used in a recent government publication, and also *in another sense* in a somewhat earlier private paper by another writer.

The undersigned now wishes to appeal to all those interested in the advancement of the study of geomorphology, to aid in the preparation of this dictionary—already over three hundred terms have been catalogued—by sending to him the following data for any topographic term, in any language, which may be met with in the course of study or reading:

1. The new term, and the inventor or first user of it in the given sense.
2. The etymology of the term, if possible.
3. The publication, volume, page and year, where first used.
4. The original definition, preferably *quoted.*
5. The cited examples of the form or combination of forms to which the inventor, or first user, applied it.

The above need not be written on catalogue cards, but preferably should be typewritten. The latter is not at all a prime requisite, however.

Of course the contributors to the work will be given full credit for the aid they render. Letters should be addressed to

Cleveland Abbe, Jr.
1441 Florida Avenue, N. W.,
Washington, D. C.

AMŒBÆ FOR THE LABORATORY.

To the Editor of Science: Just at this season many teachers of zoology are looking for Amœbæ for their students, and as I remember well the difficulty that is often experienced in securing them in considerable numbers and of good size, I venture to give a very simple method of obtaining them which I hit upon accidentally two years ago and have found highly satisfactory ever since; it is quite possible that this method is in use by others and it may be that it has been recorded, but if so it has escaped my notice. Two years ago while examining some insect eggs which were attached to the lily-pads on a pond on my summer place, I noticed numerous amœbæ. So I suggested to my laboratory assistant the following autumn that he get a considerable number of lily-pads and remove the slime which adheres to the under surface with a spatula and put it in a shallow glass aquarium containing water six or eight centimeters deep. This he did, placing the vessel near a window, and in a week or two the amœbæ were very large and abundant on the surface of the sediment at the bottom of the aquarium. We followed the same method this year with equally satisfactory results, so that I believe it to be as reliable as it is simple, and I would strongly recommend it to any one who has had trouble in securing this useful animal.

A. W. Weysse.
Boston University.

DO RHIZOPODS DIE A NATURAL DEATH?

To the Editor of Science: In various works on zoology and geology statements like the following are usually found, and, so far as I know, have never been questioned: '* * * in the oceans Globigerinæ live in countless numbers. Dying, their shells accumulate to form thick layers on the ocean bottom.'

We know that as a rule protozoa do not die a natural death, as that term is used in reference to higher animals. They subdivide and we have two protozoa, these subdivide and there are four, and so on to the end of time. The fact that Globigerinæ protect themselves with a shell which consists of a series of chambers does not prevent them from withdrawing from their shell for purposes of conjugation and reproduction somewhat as do the diatoms. I would be very much obliged if some reader of Science who has studied the habits of rhizopods would answer the question, given above, in the correspondence department of your journal.

L. C. Wooster.
Department of Biology and Geology,
State Normal School, Emporia, Kansas.

BODY TEMPERATURE.

To the Editor of Science: In Science for September 9, Mr. Woods Hutchinson requests references to articles dealing with body temperature. If he has not already seen the vol-

ume, he will be interested in 'Principles of Animal Nutrition,' by H. P. Armsby, director of the Pennsylvania State Agricultural Experiment Station, which discusses this and related topics and summarizes a large amount of interesting information. The question is also taken up by Dr. Armsby in 'The Isodynamic Replacement of Nutrients,' SCIENCE, N. S., 18 (1903), No. 459, pp. 481–487.

Some experiments which have to do with temperature during fever with especial relation to the influence of the abnormal body condition on metabolism are summarized in Bulletin No. 45 of the Office of Experiment Stations, entitled 'A Digest of Metabolism Experiments.'

The *Jahresbericht der Tier-Chemie* contains numerous titles and abstracts of articles which deal with the question under consideration. The Department of Agriculture library contains a set of this journal, which can undoubtedly be found also in a number of other public or university libraries.

C. F. LANGWORTHY.
OFFICE OF EXPERIMENT STATIONS,
DEPARTMENT OF AGRICULTURE.

MATHEMATICS AND METAPHYSICS.

ON reading the interesting lecture of Professor Josiah Royce on 'The Sciences of the Ideal,' and learning that all leveling and serial relations come from the same root, one is reminded of the computer of the coast survey, who decided that 8×8 is not exactly 64, but plus or minus a small quantity, according to the table of logarithms he used. If mathematics and metaphysics coalesce where shall we rest? Will our mathematicians become 'flabbier and flabbier'?

A. HALL.

October 10, 1904.

SPECIAL ARTICLES.

WHAT IS AN ELECTRIC CURRENT?*

THE question of the day which seems to appeal most strongly to the physicist is: What is taking place in a metallic conductor on the terminals of some electrical source?

Rowland's rotating disk showed that a positively charged body moving in a positive direction, and a negatively charged body moving in an opposite direction, produce the same electromagnetic effects in the surrounding field.

Rutherford's work in deflecting the electrons of a radioactive body is in entire harmony with Rowland's result. Positively charged masses of radiant matter are deflected in the opposite direction from negatively charged matter, when acted upon by a magnetic field, the masses are, of course, moving in the same direction. These charged particles of moving matter are, in effect, superposed, or perhaps juxtaposed electric currents moving in the same direction. If either the α or the β particles could be reversed in direction, then the magnetic field would deflect them in the same direction. They would then each create the same external magnetic effects. They would then represent superposed currents of opposite sign, moving or flowing in opposite directions.

All of this means that a positive current of electricity flowing in a positive direction is not a negative current of electricity flowing in a negative direction. These two currents involve the motion of masses of matter in opposite directions. Do these currents co-exist in the conducting wire? Is a direct-current dynamo pouring oppositely moving electrons into the opposite ends of the conductor? After a few thousand years of continuous use, may it become clogged and lose in part its conductive properties, acquiring perhaps meanwhile radioactive properties?

Wheatstone made a famous experiment on the discharge of a Leyden jar, which was thought very instructive in his day. But did his contemporaries really learn the lesson which that experiment teaches. The sparks at the two gaps nearest the terminals of the conductor were formed before the central spark appeared. Have we not here evidence that the positive and negative currents, moving in opposite directions, begin at the opposite terminals, and only become superposed after an appreciable time interval?

In a Geissler tube having a length of about

* Abstract from an address on 'Present Problems in Physics,' at the Congress of Arts and Science.

fifty feet, J. J. Thomson found the positive luminescence to travel in a direction opposite that of the cathode particles in the Crookes tube, with a velocity somewhat greater than half the velocity of light. If this involved an actual transfer of electrons by some hand to hand process, it did not involve matter which was concerned in producing spectrum lines, since no Doppler effect is shown in the positive luminescence (Spottiswoode and Moulton). It might be suggested that the positive luminescence was here produced by cathode rays which found their way around the bends of this long tube and finally struck the anode, but this seems very improbable, especially in view of the Wheatstone experiment.

It seems probable that the discharge from a Leyden jar, or from a Holtz machine, differs from that of a spark coil or from the current originating in an armature of a dynamo. If both positive and negative currents exist in these last-named circuits, they are superposed in their origin, where the E.M.F. is produced. In the Holtz machine, as in the Leyden jar discharge, the positive and negative charges are separately accumulated, and in this case the positive and negative currents may perhaps be prevented from being superposed in the same discharge conductor. One terminal of the machine or jar may be connected to a large many-pointed conductor, suspended in the outer air on silk fibers. That terminal of the machine is then grounded on the dust particles in the air. The other terminal may be grounded either in a like manner, or on the gas pipe. Wheatstone gaps may be made in either of these circuits of unipolar discharge. These gaps may be either in open air or in tubes having any degree of exhaustion. Wheatstone's experiment under these conditions is likely to tell us something about the motion of positive and negative electricity in a conductor.

It is interesting to observe here that a Crookes tube will operate well in either of these unipolar circuits. The same exposure to the X-ray will give pictures of equal density when developed together in the same bath. In one case, however, the cathode terminal is connected to the negative terminal of the machine. In the other circuit, it is connected to the air contact, and is acted upon only inductively by the anti-cathode which is connected to the positive terminal of the machine. In the first case the cathode discharge appears normal and stable. In the second case, it seems unsteady, it is greatly affected by the motion of surrounding bodies, and it can be suppressed entirely by bringing the open hands near the tube so as to partly enclose it.

The pointed air terminal may be replaced by a flaming gas torch made of gas-piping closed at its upper end and having many small perforations, the lower end being connected with the gas main by rubber and glass tubing, the latter being kept dry by heating. The carbon particles then serve as the carriers. An insulated water tank in open air, from which the water escapes in a fine spray, is also effective.

If what we call the free charges on the terminals of the machine are delivered to the small particles which float off into the air, it would seem that in these unipolar discharges we may find that even if positive and negative currents are superposed they may not be equal in value. For certainly in both circuits the dominating action comes from the machine.

Francis E. Nipher.

SCIENTIFIC NOTES AND NEWS.

Professor Simon Newcomb has been elected a corresponding member of the Vienna Academy of Sciences.

It is reported that the Nobel prize for medicine will this year be awarded to Dr. Robert Koch.

Professor William T. Sedgwick, head of the biological department of the Massachusetts Institute of Technology, has been elected an honorary member of the New England Water Works Association.

Professor Martens, director of the Institute for Testing Materials at Berlin, has been elected a member of the Berlin Academy of Sciences.

Professors Paul Mansion, professor of mathematics, at the University of Genth, M.

Laisant, of the Ecole Polytechnique, Paris, and Dr. Giuseppe Peano, professor of mathematics at the University of Turin, have been elected honorary members of the Physico-mathematical Society of Kasan.

PROFESSOR E. SALKOWSKI, chief of the Chemical Laboratory of the Pathological Institute of the University of Berlin, has been elected a foreign member of the Society of Sciences at Upsala.

DR. O. DRUDE, who has recently been in this country to attend the International Congress of Arts and Science, has celebrated his twenty-fifth jubilee as professor of botany at the Dresden Institute of Technology. Professor Drude is also director of the Botanical Garden at Dresden.

WE learn from *Nature* that the friends of Professor Carey Foster, F.R.S., are taking the occasion of his recent retirement from the principalship of University College, London, as an opportunity of showing their appreciation of him by promoting a fund with the object of having his portrait painted for presentation to the council of the college, and a replica for presentation to Mrs. Foster. The president of the movement is the Right Hon. Lord Reay, and the vice-presidents are Sir Norman Lockyer, Sir Oliver Lodge and Sir Arthur Rücker.

MR. N. C. HAMNER, a graduate of the University of Virginia in the class of 1902, and Mr. A. W. Clark, a graduate of the University of Vermont in the class of 1904, have been appointed assistant chemists in the Agricultural Experiment Station of the Pennsylvania State College. The U. S. Secretary of Agriculture has appointed Mr. F. W. Christensen assistant expert in animal nutrition, in conformity with the agreement recently made with the station, and assigned him to duty in connection with the cooperative experiments with the respiration calorimeter. Mr. R. E. Stallings has been transferred from the position of assistant chemist to that of assistant in animal nutrition, and during the remainder of the year will devote his entire time to the investigations with the respiration calorimeter.

AT a recent meeting of the board of trustees of the Ohio State University, James S. Hine, associate professor of zoology and entomology, was granted leave of absence for the winter term of the present college year. He will spend the time in Guatemala collecting zoological specimens for the museum of that institution.

SIR DYCE DUCKWORTH has been appointed medical referee to the British treasury and adviser to the pensions' board, *vice* Dr. Lionel Beale, F.R.S., resigned.

THE Gedge prize in physiology of Cambridge University, has been awarded to Mr. K. Lucas, fellow of Trinity, for his paper on 'The Augmentor and Depressor Effect of Tensions on the Activity of Skeletal Muscle.'

AN examination of Black River near Bessemer was made last summer by a Michigan geological survey party including Mr. W. C. Gordon and C. E. Smith. The latter has had to resign from the Louisiana Survey on account of malaria.

MR. DESMOND FITZGERALD, of Boston, has recently returned from Manila, where he was sent by the United States government to report on questions of sanitation.

MR. JOHN MORLEY made the address at the celebration of Founder's Day at the Carnegie Institute, Pittsburg.

A MEMORIAL meeting was held at Chicago on October 23 in honor of the late Dr. N. S. Davis. The South Park commissioners have named a park in his honor.

PROFESSOR CLEMENS A. WINCKLER, the eminent chemist, died at Dresden on October 8, at the age of sixty-six years.

PROFESSOR MAX BARTELS, of Berlin, known for his publications on ethnology, died on October 22, at the age of sixty-two years.

DR. K. S. LEMSTRÖM, professor of physics at Helsingfors, died on October 2.

THE U. S. Civil Service Commission invites attention to the examination for scientific aid in the Department of Agriculture, applications for which may be filed at any

time. Eligibles are desired at this time to fill a vacancy in the position of scientific aid (male), with a knowledge of agricultural statistics, in the Bureau of Statistics, at $480 per annum, and other similar vacancies as they may occur. For the vacancy mentioned, only such applications will be considered as are filed with the commission at Washington prior to the hour of closing business on November 30, 1904. Applicants must be graduates of colleges in courses of study tending to qualify them for the scientific work of the Department of Agriculture. They are not assembled for this examination, but must submit all the required material with their applications.

The New York Historical Society has received a gift of about $200,000 toward its new building to be erected on Central Park West between Seventy-sixth and Seventy-seventh Street.

The French government proposes to establish a museum of industrial hygiene.

Mr. Seddon, the premier of New Zealand, has introduced a bill to prevent the further exportation of Maori antiquities from that colony. The penalty is fixed at £100.

Mylius Ericksen's expedition, after two years and a half exploration of Greenland, returned on November 6 to Copenhagen. It is said that valuable ethnological records have been collected, the explorers having lived with the natives, studying their language and customs.

The College of Physicians of Philadelphia announces that the next award of the Alvarenga prize, amounting to about one hundred and eighty dollars, will be made on July 14, 1905. Essays may be on any subject in medicine, but can not have been published. They must be received by the secretary of the college, Dr. Thomas R. Neilson, on or before May 1, 1905.

The South African Philosophical Society has asked for a charter under the name of the Royal Society of South Africa.

The National Association of State University Presidents met last week at Des Moines, Ia.

The twenty-second congress of the American Ornithologists' Union will convene in Cambridge, Mass., on Monday, November 28, at 8 P.M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings, open to the public and devoted to the reading and discussion of scientific papers, will be held in the Nash lecture-room, University Museum, Oxford St., beginning on Tuesday, November 29, and continuing for three days. Information regarding the congress can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

The fourth Pan-American Medical Congress will meet in Panama during the first week in January. According to the New York *Medical Record,* the Panama government has appropriated $25,000 for the scientific sessions and the entertainments. The afternoons will be devoted to the scientific sessions and the mornings and evenings to trips and social functions. So far as can be learned, the program in Panama will be a reception on the first day by President Amador, and the formal opening session of the congress the same evening. On the second day, an excursion to the canal in the morning, meeting of the various sections in the afternoon, and a banquet in the evening. On the third day, an excursion down the bay to Taboga Island, where a Panama breakfast will be served, scientific sessions in the afternoon, and a ball in the evening. On the fourth day, an excursion to the U. S. army barracks in the morning, section meetings in the afternoon, and the formal closing session in the evening. On the fifth day, an excursion to the plantation of the United Fruit Company; and on the afternoon of this day, those who intend going to Cuba by way of Jamaica to attend the meeting of the Public Health Association, will sail for Kingston, while those who intend going by way of Vera Cruz, or returning home by way of New Orleans or New York, will remain until the following Tuesday.

The School of Demonstration in Plant and Animal Breeding conducted at St. Louis un-

der the auspices of the American Association of Agricultural Colleges and Experiment Stations appears to have been a marked success. It was no little work to keep such a school in running order under the circumstances of a large shifting audience, but Professor J. H. Shepperd, of the North Dakota Agricultural College, who was in charge of this work, seems to have accomplished what it was intended the school should be, carrying out the full detail of the work as to preparation of buildings, equipments and the construction of a daily program. Speakers came from nearly all the experiment stations and colleges, and there was presented, before this audience of practical farmers and animal breeders, many of the newest and best ideas in regard to plant and animal breeding. During the last session, October 3–15, the demonstration work upon plant breeding was emphasized, showing that much work is being done at the experiment stations at the present time in developing broader methods. Results were divided into breeding cereals for resistance to drought and plant diseases. Professor Ten Eyck, of the Kansas Agricultural College, is making extended experiments upon drought resistance. Professor H. L. Bolley, of the North Dakota Agricultural Experiment Station, gave two lectures on breeding cereals for disease resistance. Assuming that the struggle for existence among plants and a survival of the fittest represents the principle which the breeder should use, Professor Bolley has for several years conducted plant breeding experiments eliminating by a harsh environment or the promotion of disease weak strains and types in a farm crop.

As we have already noted, Captain Robert S. Scott was expected to open the new session of the Royal Geographical Society on November 7 with an account of the British Antarctic expedition. We learn from the London *Times* that at subsequent meetings Lieutenant Royds will deal with the meteorology of the expedition, Mr. Ferrar with the geology, Dr. Wilson with the zoology, and Mr. Bernacchi with the terrestrial magnetism. Captain Scott has consented to tell the story of some of the leading incidents of the expedition to young people about Christmas, when there will be an abundance of lantern illustrations. At the second meeting of the session, on November 21, Dr. Hunter Workman will give an account of the explorations in the Western Himalaya recently accomplished by himself and his wife, Dr. Fanny Bullock Workman. At the next meeting, on December 12, Major Delmé Radcliffe will deal with the results of the Anglo-German Boundary Commission in East Africa, on which he was the principal British representative. After Christmas, Colonel L. Jackson, R.E., will give an account of another Anglo-German Boundary Commission, that which was recently at work in Nigeria. Another African paper will be that by Mr. B. H. Jesson, the surveyor who accompanied Mr. McMillan's expedition; he will deal with the portion of the Sobat basin in Abyssinia which has not hitherto been explored. Colonel P. H. M. Massy will give an account of his explorations in Asia Minor, which extended over several years. There will be two South American papers, one by Dr. H. Hoek on explorations in various parts of South America, while a paper by Mr. C. Reginald Enock will give an account of two recent journeys in outlying parts of Peru. It is hoped that during the session one of the leading members of the recent Tibetan mission will give an account of the geographical results which were obtained, and which are believed to be of considerable importance.

UNIVERSITY AND EDUCATIONAL NEWS.

THE alumni of the Massachusetts Institute of Technology are collecting a fund for current expenses, which now amounts to over $100,000 to be used in the course of the next five years.

HARVARD University has received from Miss Maria Whitney a gift of $5,000, to be known as the 'Josiah Dwight Whitney Fund,' the income of which is to be applied as a scholarship, not exceeding $200, or as two scholarships of $100 each, to aid meritorious students in the study of field geology or geography in the summer months, preferably in the mountain region of the western United States.

Any excess of the annual income may be applied at the discretion of the department of geology and geography in aiding meritorious students in making other excursions.

Dr. Isaac Roberts, the eminent astronomer, has bequeathed his residuary estate, probably over $150,000, to the University of Liverpool and the University Colleges of North and South Wales, for the purpose of founding scholarships, with preference to astronomy, biology, zoology, botany, chemistry, electricity, geology and physics.

Dr. John Grieve left $8,000 to the medical faculty of the University of Glasgow, which will be used to endow a lectureship in physiological chemistry.

William Mackenzie has presented to the University of Toronto the collection of fossils made by Dr. George E. Matthew, of St. John, N. B. The collection contains many type specimens.

Mr. Henry Evans, of Trinity College, Cambridge, has bequeathed to the university his collection of British Lepidoptera.

The following appointments have been made at the Massachusetts Institute of Technology: Messrs. Roy D. Mailey, George A. Abbott and Charles A. Kraus, research assistants in physical chemistry; Dr. Erastus G. Smith, research associate, and George C. Bunker, research assistant, in sanitary science.

At Oberlin College the following appointments have been made: W. D. Cairns, A.M. (Harvard, 1898), advanced from instructor to associate professor of mathematics; Miss Florence Fitch, Ph.D. (Berlin, 1903), to be associate professor of philosophy; Mr. C. H. Burr, A.B. (Oberlin, 1903), to be assistant in physics; Mr. W. H. Chapin, A.B. (Oberlin, 1904), to be assistant in chemistry; Mr. J. R. Luckey, A.B. (Oberlin, 1904), to be assistant in mathematics and physics; Frederick Anderegg, professor of mathematics, has returned after a year's absence abroad.

A. J. Carlson, Ph.D. (Sanford, '03), instructor in physiology in the University of Pennsylvania, has been appointed associate in physiology in the University of Chicago.

At the University of Oklahoma the following are giving instruction for the first time: C. C. Major, M.E. (Cornell), in charge of engineering; C. E. Gabel, Ph.D. (Vienna), instructor in embryology and histology; E. G. Woodruff, A.M. (Nebraska), instructor in mineralogy; and H. C. Washburn, Ph.C. (Michigan), instructor in pharmacy.

It has been arranged that the installation of Lord Kelvin as chancellor of the University of Glasgow shall take place in the Bute Hall, on Tuesday, November 29.

At the annual meeting of the governors of Durham University College of Science, Newcastle-on-Tyne, the name of the college was changed to the Armstrong College of Science in the University of Durham. Sir Isambard Owen, vice-dean of the faculty of medicine in the University of London, was elected principal of the college in place of the late Dr. H. P. Gurney, who was killed while mountaineering in Switzerland in August.

Professor E. G. Coker, of McGill University, has been elected to the chair of civil engineering at the Finsbury Institute of Technology, London, in succession to Professor Dalby.

At King's College, London, Professor Caldecott will lecture on general psychology during first and second terms of coming session; Professor Halliburton, on histological psychology, during first term, and Dr. C. S. Myers, on experimental psychology (with demonstrations and laboratory work), during the second and third terms.

At Cambridge Mr. P. V. Bevan, M.A., fellow of Trinity College, has been appointed demonstrator of experimental physics in succession to Mr. Skinner, who has resigned. Mr. C. Chittock, B.A., of Trinity College, has been appointed assistant demonstrator in succession to Mr. Bevan.

M. H. Poincaré, professor of mathematical astronomy at the University of Paris, has been appointed professor of general astronomy in the Ecole Polytechnique.

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THE SPHERE OF BACTERIOLOGY.*

IT is possibly a contemporary delusion that we are living in a period of unexampled mental activity. The life of the intrepid modern scholar affords opportunity for self-deception. If one becomes a member of a sufficient number of learned and quasi-learned societies, and attends committee meetings for an adequate variety of purposes, the impression of profitable intellectual endeavor may be prematurely acquired. There is much, however, to account for the prevailing sensation of breathless advance. The physiological and psychological accompaniments of a breakneck pace are not altogether lacking in the modern world, and there are bacteriologists in particular who will lend a credent ear to affirmations of the rapidity of scientific progress. However this may be, few can question that the development of the science of bacteriology has been marked by an unusual tempo. To those who have followed this development closely, discovery has trod upon the heels of discovery in bewildering succession. The scant thirty

* Read before the Section of Bacteriology, International Congress of Arts and Science, Universal Exposition, St. Louis.

years of its history have been crowded with feverish activities which have found their best justification in the results accomplished. At present the science touches nearly many human interests and sustains manifold and far-reaching relations to the whole body of natural knowledge. It is no matter for surprise that such should be the case with a science that owes its birth to a chemist, that concerns itself with microscopic organisms belonging both to the plant and animal kingdoms, and that extends its ramifying branches into the regions of medicine, hygiene and the industrial arts.

In several respects the history of bacteriology might be held to epitomize that of the other natural sciences or of the living organism itself. Advance in complexity of structure entails greater complexity of relations and adjustment; maturity has more extensive connotations than youth. Bacteriology is a relatively youthful branch of the stream of knowledge, but in late years it has perceptibly widened its banks. It has even encroached upon certain neighboring sciences. Modern physiography uses the term *piracy* to designate the capture by one stream of that portion of a watershed legitimately belonging to another stream. In the same way, one natural science, owing to peculiarities in its subject matter, in its evolutionary history or in the tools with which it works, may enter upon a piratical career and appropriate territory which for various reasons has remained unexploited by the science to which topographically it may seem to belong. This annexation of neighboring fields has been not uncommon among the natural sciences, and bacteriology has not shown itself free from the general tendency. A notorious instance of piratical conduct on the part of bacteriology is the virtual appropriation of the whole field of microbiology. Perhaps most familiar in this connection are the discoveries concerning the life histories of various microscopic animal parasites. The tracing out of the relations between parasites and hosts in Texas fever, malaria and dysentery has by no means been exclusively or even largely the work of zoologists. On the contrary, it is well known that much of the most important work in this direction has been carried out by bacteriologists and that the literature on these topics is chiefly to be found in the technical bacteriological journals. A recent instance of this tendency is the renewed study of the remarkable protozoa called trypanosomes, which has in large part been undertaken by bacteriologists and by bacteriological methods. Perhaps the most notable triumph yet accomplished in this field is the successful cultivation of these pathogenic protozoa outside of the animal body, a feat which has been achieved by one of the foremost of American bacteriologists. The exploitation of zoological territory by bacteriological workers is one of the many instances of successful borderland invasion and, like the Louisiana Purchase, illustrates the impotence of territorial lines to prevent natural expansion. Many reciprocal piratic inroads among the sciences are due to the acquisition by one science of new tools which, when workers become generally acquainted with their use, are found to be applicable to other problems in other fields. Bacteriological technique is one of these efficient tools the possession of which conduces to piracy; it can, however, never be forgotten that bacteriology itself owes its powerful equipment to a study of spontaneous generation which was undertaken primarily for the interest felt in its philosophical bearings.

Bacteriology stands in close relation to at least four other more or less defined fields of natural knowledge: to medicine, to hygiene, to various agricultural and industrial operations and pursuits and to biology

proper. Bacteriology, as has been often said, is the youngest of the biological sciences and perhaps for this reason has as yet contributed relatively little to the enrichment of the parent science. Morphologically the bacterial cell is so small and so simple as to offer many problems of surpassing interest but of great difficulty. The question as to whether a bacterium is a cell without a nucleus or a free nucleus without any cytoplasm or a cell constituted in the main like those of the higher forms of life has, to be sure, been practically settled in favor of the latter view. But there are other debated and debatable morphological questions to which up to the present no satisfactory answer has been given and to which our current microchemical methods are perhaps unlikely to afford any solution. On the physiological side, the achievements of bacteriology in behalf of general biology have as yet been far from commensurate with its potentiality. This may be partly because of its temporary engrossment in other seductive lines of research, partly because of the lack of workers adequately trained in bacteriological methods and at the same time possessed of an appreciation of purely biological data. It may be justly urged that a rich harvest of fundamental physiological facts waits here for the competent investigator.

There is no need to dwell in detail upon the manifold practical applications of bacteriology to the arts and industries. Particularly in agriculture and kindred occupations have the advances in bacteriology been immediately and intelligently utilized to bring forth in turn new facts and unveil new problems. The processes of cream-ripening and vinegar-making, the phenomena of nitrification, of denitrification and nitrogen-fixation, the modes of causation of certain diseases of domestic plants and animals, have all been elucidated in large measure by bacteriological workers. A new division of technological science, dealing with the bacteriology of the soil, of the dairy and of the barnyard, of the tan-pit and the canning factory, has already assumed economic and scientific importance.

It is often a temptation to distinguish radically between pure science and applied science and to look upon the latter as unworthy the attention of the philosophically minded. True science can admit of no such distinction. No thing in nature is alien to her. She can never forget that some of the most fruitful of scientific theories have been the outcome of the search for the utilitarian. Man's knowledge of the universe may be furthered in various ways. It is well known that the work of Pasteur was particularly characterized by applications to the problems of pure science of knowledge acquired in the study of the practical. One thing plays into the hands of another in wholly unexpected fashion. An attempt to improve the quality of beer gives birth to the germ theory of fermentation, and this in turn to the germ theory of disease; the chemistry of carbon compounds leads to the discovery of the aniline dyes, and these same aniline dyes have made possible the development of microchemical technique and thrown open spacious avenues for experiment and speculation; the attempt to obtain a standard for diphtheria antitoxin has resulted not only in the achievement of the immediate practical end, but in the discovery of unexpected theoretical considerations which have dominated the progress of an important branch of scientific medicine during the last five years. It will not be a hopeful sign for the advancement of science when the worker in pure science ceases to concern himself with the problems or avail himself of the facilities afforded by the more imminently utilitarian aspects of natural knowledge.

In the quarter century of its history

bacteriology has sustained close and mutually advantageous relations with the science of medicine. This has been the scene at once of its greatest endeavors and of its greatest triumphs. To recount these would be superfluous. There is hardly an hypothesis in scientific medicine that has not been freshened and modified, hardly a procedure in practice that has not been influenced by bacteriological conceptions. The experimental method in particular has been given new support and received brilliant justification. Experimental pathology and experimental pharmacology practically owe their existence to the methods and example of bacteriology. The security afforded by aseptic surgery has made possible physiological exploits that could not otherwise have been dreamed of, a pregnant illustration of the way in which applied science may directly further the advance of pure science. Conspicuous as these achievements of bacteriology have been, it can not be truly said that the field is exhausted. There is hardly an infectious disease of known or unknown origin that does not still harbor many obscurities. Some of the most difficult problems that medicine has to face are connected with the variation and adaptation of pathogenic bacteria. The phenomena of immunity, certainly among the most complicated and important that human ingenuity has ever set itself to unravel, still await their full description and interpretation. The study of the ultra-microscopic, or perhaps more correctly the filterable viruses, is being prosecuted with great energy and in a sanguine spirit. The extension of bacteriological method into the field of protozoon pathology has been already referred to and constitutes one of the latest and most hopeful developments in the study of the infectious diseases. Medicine, perhaps more than any other department of human knowledge, is most indebted to, and maintains the most intimate relations with, the science of bacteriology.

At the present time the relations of bacteriology to public hygiene and preventive medicine seem to me of particular importance, and it is upon this theme that I wish chiefly to dwell. Personal hygiene is not necessarily pertinent to this topic, but falls rather into the same province with the healing art. Matters of diet, of clothing, of exercise, of mental attitude affect the individual and contribute more or less largely to his welfare. But except in so far as the individual is always of moment to the community, they do not affect the larger problems of public hygiene. The pathological changes that take place in the tissues of the diseased organism and the methods that must be employed to combat the inroads of disease in the body of the individual patient must for a long time to come remain questions of supreme importance to the human race. But over and above the treatment and cure of the diseased individual, and the investigation of the processes that interfere with the proper physiological activities of the individual organism, rises the larger and more far-reaching question of the prevention of disease.

Racial and community hygiene are but just beginning to be recognized as fields for definite endeavor. The project may seem vast, but the end in view is undoubtedly the promised land. More and more will the problems of curing an individual patient of a specific malady become subordinated to the problem of protection. More and more will scientific medicine occupy itself with measures directed to the avoidance of disease rather than to its eradication.

Whatever else may be said of it, this is certainly the age of deliberate scrutiny of origins and destiny. Man no longer closes his eyes to the possibilities of future evolu-

tion or to those of racial amelioration. If we are to remain to a large extent under the sway of our environment, we can at least alter that environment advantageously at many points. We are no longer content to let things as we see them remain as they are. On the surface the wider relations of disease have often seemed of little significance as, before Darwin, the so-called fortuitous variations in plants and animals were considered as simple annoyances to the classifier; the causes of this variation were deemed hardly worth investigation. The rise and fall of plagues and pestilences have been readily attributed to the caprices of the *genius epidemicus*, and it has sometimes been thought idle to ascribe recurrent waves of infection to anything but 'the natural order.' Another phase, entered upon later and from which we have not yet entirely emerged, possesses its own peculiar perils. In meditating on the cosmos the agile mind is always tempted to fill in the gaps of knowledge with closely knit reasonings or fantastic imagery. The imaginative man of science still frequently finds himself beset with the temptation to erect an unverifiable hypothesis into a dogma and defend it against all comers. It is now fortunately a truism that a more humdrum and plodding course has proved of greater efficacy in advancing natural knowledge. Theories that stimulate to renewed observation and experiment have been of the greatest service, but unverifiable speculations have often been a barrier to further advancement. Metaphysics tempered with polemic is not science, whatever be its allurements.

If the attainment of a rational position in public hygiene, community hygiene or preventive medicine must then be regarded as the main objective point in the campaign against disease, it follows that the part played by bacteriology in this advance will be an important one. The relations of bacteriology to public hygiene are fundamental. The etiology of many of the most widespread and common diseases that afflict mankind is intelligible only through the medium of bacteriological data. The modes of ingress of the invading microorganisms, the manner of persistence of the microorganism in nature, the original source of the infectious material and all the varied possibilities of transmission and infection can be apprehended only through the prosecution of detailed bacteriological studies. It is only by this means that the weak point in the chain of causation can be detected and the integrity of the vicious circle attacked. Success will inevitably depend upon a thorough understanding of the circumstances governing and accompanying the initiation and consummation of the disease process. Yellow fever can not be suppressed by burning sulphur or by enforcing a shot-gun quarantine, the bubonic plague is not to be combated by denying its existence.

In the warfare against the infectious diseases a rational public hygiene is ready to avoid the mistake of beating the air. A preliminary survey of the possibilities reveals several distinct types of disease; those that are practically extinct or far on the road to extinction in civilized communities, those that remain stationary, or decline but slightly, and those that show a more or less consistent increase. The economy of energy would suggest that it is not a far-sighted policy for public hygiene to focus its endeavors exclusively upon those diseases that are yielding naturally before the march of civilization. The conditions under which civilized peoples live to-day are in themselves sufficient to render the foothold of many infectious diseases most precarious. What nation now fears that typhus fever will become a national scourge, or who looks to see the citizens of London driven into the fields by the Black

Death? It is of course true that the continuance of this immunity can be secured only by unremitting watchfulness, although so long as existing conditions of civilized life are maintained the recurrence of great epidemics will be relatively remote. The pestilences that once stalked boldly through the land slaying their ten thousands are now become as midnight prowlers seeking to slip in at some unguarded door within which lie the young and the ignorant. Already some once dreaded maladies have become so rare as to rank as medical curiosities, and their ultimate annihilation seems assured.

There are other diseases, however, that civilized life, or, at least, modern life, appears to leave substantially unchecked, and some that it even fosters. These may be considered as shining marks for the modern hygienist. The scale between hygienic gain and loss is always in unstable equilibrium. There is no such thing as consistent improvement all along the line. As Amiel wrote in his journal, 'in 1,000 things we advance, in 999 we fall behind; this is progress.' It is almost a biological axiom that progress in one particular entails loss in others. To maintain the efficiency of all parts of the complex of civilization calls for eternal vigilance. It may be that while we are waxing complacent over the fact that the opportunities for infection with certain parasites are diminishing and that other parasites are gradually losing what we vaguely denominate as their virulence, unforeseen and greater evils are raising their heads. The increasing exemption from certain diseases will itself lead to an increased prevalence of others as diversely vulnerable age-groups are formed. In general it will occur that the diseases peculiar to the advanced age-groups will increase as the diseases of childhood and youth succumb to hygienic measures. A different age-distribution of the population will bring in its train new problems of preventive medicine, which must be successfully solved if the issue is to be fairly met.

There are not lacking instances of a dawning consciousness on the part of mankind that the proper development of public hygiene involves a far more comprehensive view of its relations than has hitherto been taken. The study of tuberculosis is being approached by methods of unexampled broadness. We are just beginning to recognize the way in which the roots of this destructive malady are well-nigh inextricably interwoven with the whole social fabric. Bacteriological, architectural and economical data are all levied upon for contribution to our knowledge of what is universally recognized as one of the most important of all human diseases. Here, as elsewhere, the care and cure of the infected individual still looms large, but beyond and above this is beginning to be placed the prevention of infection, the drying up of the stream at its source. That for this heavy task public hygiene will require the aid of many workers in many different fields is abundantly evident. For all of them, however, bacteriology must furnish the only definite point of view. In the full consideration of the 'exciting causes' the tubercle bacillus can never be allowed to drop into the background. Given foul air, insufficient food, inhalation of dust, excessive and exhausting labor and the other deplorable accompaniments of modern industrialism, and it still must be constantly kept in mind that without the tubercle bacillus these predisposing causes would never result in a single case of tuberculosis. On the other hand, without these contributing factors, the tubercle bacillus would almost sink to the level of the negligible 'non-pathogenic organism.' Witness the impotence of the bacillus to produce infection or even maintain itself

in the tissues of those individuals able to live an outdoor life.

It is evident that in the case of tuberculosis the forces of civilization are on the whole working for its extinction rather than for its perpetuation. The available statistics demonstrate that before the modern movement for the suppression of the disease began, and, in fact, even before the discovery of the tubercle bacillus, consumption was already on the decline in widely separated parts of the world—in London, in Boston and in Chicago. It is, perhaps, significant that consumption is now one of the tenement house problems and that as such it occupies a strictly delimited field. As yet the campaign against tuberculosis has been a desultory one, waged by a few enthusiasts without adequate material or moral support on the part of the community at large, but signs are multiplying that this condition will be a transient phase. The comparative absence of intelligent, systematic endeavor for the suppression of disease is certainly a curious phenomenon in an age of otherwise extensive coordination and organized action. The executive talents and restless energy lavished on commercial, industrial and engineering projects may some day be turned to devising and carrying out hygienic measures. If it were necessary to find an argument in the economic value of human life it would be readily forthcoming. The recent movements for the study and suppression of tuberculosis mark one of the first attempts to apply bacteriological knowledge in a determined and radical way to a problem of public hygiene. As regards the ultimate extinction of tuberculosis, there may be more or less groping after ways and means, but there need be no misconception as to the scope of the problem.

There are other fields where a similar mode of procedure based on ascertained bacteriological facts and principles has been indicated and is being at least in part carried out. In typhoid fever the evidence from epidemiology has long pointed unmistakably to drinking water as being the chief vehicle of infection, and the first step towards suppression of this disease has been already taken in most civilized countries. The last half of the nineteenth century witnessed an improvement in the sanitary quality of public water-supplies which has diminished perceptibly the death rate from typhoid fever. This change has been in part effected by the introduction of water from unpolluted sources, in part by the installation of sand filters. To cite a few well-known cases. For five years before the introduction of a filtered water the annual typhoid fever death rate in Zurich, Switzerland, averaged 76; in the five years following the change it averaged 10. In Hamburg, Germany, for a corresponding period before filtration, the typhoid death rate was 47; after the change it fell to 7. In Lawrence, Massachusetts, under similar conditions the typhoid rate was reduced from 121 to 26, and in Albany, N. Y., from 104 to 38. A similar effect has been noticed where an impure water has been replaced by water from unpolluted sources. In Vienna, Austria, the abandonment of the River Danube as a source of supply in favor of a ground water diminished the typhoid fever death rate from over 100 to about 6. In the United States, the city of Lowell not long ago exchanged the polluted water of the Merrimac River for a ground water supply, with the result that the typhoid fever death rate was reduced from 97 to 21. In spite of the remarkable facts there has been a lethargic slowness in profiting by the lessons that they teach. Many communities have remained to this day unobservant and negligent, and, especially in the United States, the condition of the average public water supply

demands radical reform. A method that has not only reduced the deaths from typhoid fever by about 75 per cent., but has also reduced the number of cases proportionately, is worthy of universal adoption. If the fatality in all cases of typhoid fever was diminished, say, from 12 per 100 cases to 3, by the use of a new drug or an antitoxin the world would ring with the discovery. The introduction of a pure water supply has achieved an analogous reduction in the death rate and confers further the enormous benefit of preventing the occurrence of a similar proportion of cases. In the city of Albany, N. Y., the annual number of deaths from typhoid fever prior to the installation of a filter plant averaged 89 during a ten-year period; in 1902 there were but 18 deaths from this cause, representing a diminution not only of 71 deaths, but of over 700 cases.

Important as is the function of a pure water supply in preventing typhoid fever, it is now clear that public hygiene can not stop here. In some countries, as in Germany, for example, where the larger cities and towns are supplied in the main with water of a highly satisfactory character, there still remains a notable residue of cases of typhoid fever. These we know are due to contact infection, to contamination of raw foods, such as milk, oysters and the like, to the conveyance of the specific germ on the bodies of flies and to similar modes of dissemination. It is a fact full of significance that the existence of these various modes of spread is recognized, that they are held to be matters of public concern and that preventive measures are being instituted under expert bacteriological control for suppressing the existing sources of infection. One of the most difficult problems in this campaign lies in the prompt recognition and rigorous supervision of the mild and obscure cases. It may be comparatively simple to isolate and disinfect with thoroughness in the franker types of the disease, but it is not clear that the danger is most critical on this side. The application of searching and delicate bacteriological tests is often necessary to determine the suitable mode of action. The dependence of public hygiene upon bacteriological data and methods has rarely been better exemplified.

The vigorous warfare that is being waged against malaria in many tropical countries affords a further and striking illustration of the utilization of existing resources for the avoidance of specific infection. It is hardly necessary to reiterate the obvious truth that malaria constitutes the chief and, perhaps, the only serious obstacle to the colonization of the tropics by the white races. Political and economic questions of the gravest import to mankind are bound up with the fortunes of a protozoon and a mosquito. The complex life-cycle of the malarial parasite offers an unusual number of points of attack. As is well known, several distinct views are current as to the best way of interrupting the continuity of transfer between man and the mosquito. It is conceivable that by the destruction of the malarial parasite within the body of man the supply of parasites for the mosquito may be cut off and the circle broken at this point. If the mosquitoes are prevented from becoming infected, man is safe. It is claimed by the adherents of one school that this method has proved very effective in certain localities where it has been systematically employed. The extermination of the parasite in the blood of man by the administration of quinine certainly constitutes an important weapon in the armory of public hygiene, whether or not it prove to be the most efficient one or the most economical in execution. In this same category are to be put the attempts to prevent the infection of the mosquito by guarding malarial patients

against the bite of *Anopheles*. It is obvious that this plan may often be difficult of execution because of the impossibility of exercising efficient control over the movements of individuals suffering from latent or recurrent infection.

A second possibility consists in the general protection against mosquito bite of all persons dwelling in infected regions. The pestiferous insect may beat its wings in vain against the windows of a mosquito-proof dwelling; if it can not come near enough to the human being to inject the contents of its poisoned salivary gland, no single case of malaria will result. In parts of Italy, it is said, this mode of prevention has been practised with brilliant success in protecting railway employees, forced by the exigencies of their calling, to reside in highly malarious localities.

A third point of attack is presented in the possibility of destroying or at least arresting the propagation of the insect host of the malarial parasite. The extermination of a number of species belonging to a widely distributed and abundant insect genus may seem in itself a gigantic task to undertake. Remembering the ambiguous success that has attended the efforts of the human race to combat the ravages of certain insects injurious to agriculture, it is not easy to be sanguine concerning the speedy extinction of *Anopheles*. It is noteworthy that the most considerable triumphs attained along economic lines have been effected by the utilization of the natural enemies of the noxious forms. Efficient foes of *Anopheles* have so far not been discovered. There is no question, however, that in definite localities the number of individual mosquitoes belonging to malaria-bearing species may be enormously diminished by the destruction of the breeding-pools. The labors in this direction of English health officials in various parts of the world have been rewarded by a decisive decrease in the prevalence of malaria.

It will not escape remark that the effect of any one or of all of these protective measures is cumulative. A diminution in the number of mosquitoes, or in the number of persons harboring the malarial protozoon in their blood, or in the number of infected or non-infected individuals bitten by mosquitoes, will inevitably produce a lessening in the amount of malaria in a given region. This will in turn diminish the opportunities for mosquitoes to become infected and will at least put a check upon indefinite extension of the disease. It is significant that a high degree of success apparently attends the enthusiastic and persistent application of any one of the measures above instanced.

While malaria, typhoid fever and tuberculosis are to-day fairly in the field of view of public hygiene, such is not the case with a host of other maladies. A beginning is made here and there, but the vast majority of the diseases that affect mankind still lack an intelligent and organized opposition. This is partly because of insufficient knowledge. At the present time the apparent increase in pneumonia presents an imperative field for research. It seems unlikely that the available modes of attacking this disease are to be exhausted with attempts to improve individual prophylaxis. A clear understanding of the tangled web of statistical, climatic, racial, bacteriological and hygienic questions that environ this urgent problem of public hygiene is likely to come only through renewed investigation of the phenomena. If it is true, as some conjecture on what seems insufficient evidence, that the virulence of the pneumococcus is increasing, what is the bacteriological strategy suited to the emergency? Or if it turn out that an increase in the number of victims to pneumonia is largely made up of those who

have escaped an early death from tuberculosis, what procedure is indicated?

We can not always take refuge from the consequences of inaction under the plea of ignorance. There are few, if any, instances where public hygiene is utilizing to the full the knowledge that it might possess. Some responsibility rests upon those who are prosecuting bacteriological studies to see that the bearings of their investigations are not overlooked or neglected by those who are constituted the guardians of the public health. There is here no question of the sordid self-interest or commercial exploitation sometimes miscalled 'practical application.' In the long run the saving of life may play into the hands of the idealist. If John Keats had not died of consumption at the age of twenty-five the modern world would be a different place for many persons. It is not possible to estimate the loss to literature, science and art since the dawn of intellectual life which must be laid at the door of the infectious diseases. The relations of bacteriology to public hygiene, if properly appreciated and cultivated, will lead to an improvement in the conditions of life which will enhance both the ideal and material welfare of the race and will give greater assurance that each man shall complete his span of life and be able to do the work that is in him.

Edwin Oakes Jordan.
University of Chicago.

Evolution of Weevil-Resistance in Cotton.

The complexity of biological problems finds another excellent illustration in the evolutionary history of the relations between the cotton plant and the so-called Mexican boll-weevil. The present indications are that both the cotton and the weevil originated in Central America. The parasitism of the beetle is certainly very ancient, if, as seems to be the case, it has no other breeding-place than the young buds and fruits of the cotton plant. Of the severity of the parasitism there is ample evidence in Texas, the weevils being able to totally destroy the crop when the climatic conditions admit of their normal increase.

It was to have been expected, therefore, that in humid tropical localities where all seasons of the year are alike favorable the cotton would have been exterminated long since, or at least that its cultivation as a field crop would be utterly impracticable unless there were means of protection against the ravages of the insect. A definite intimation of the existence of protective adaptations was incidentally gained in eastern Guatemala in 1902 when no weevils were found in a field of the dwarf cotton cultivated by the Indians, although they were extremely abundant on a perennial 'tree' cotton a short distance away. The opportunity of making a detailed study of the subject during the second quarter of the present year has revealed an interesting series of protective adaptations resulting from the long evolutionary struggle for existence between the cotton and the weevil.

Reference has been made in another place* to the extensive system of extrafloral nectaries by which the cotton of eastern Guatemala has secured the active cooperation of the kelep or weevil-eating ant, but the Central American cottons and the Indians who have been cultivating them for thousands of years have developed many other expedients of structure, habits and culture which are of more or less assistance in resisting or avoiding the weevil.

The large leafy involucre of the cotton may have been at first a protective adaptation, though the weevils later learned to enter it easily. In some of the Guatemalan sorts the bracts are grown together at the base as though the evolution of a closed

* Report No. 78, U. S. Dept. Agric., p. 4, 1904.

involucre had begun. The hairy stems assist the ants in climbing, but impede the weevils, and thus increase the chances of capture. Prompt flowering and determinate growth enable an annual variety to ripen more seed. A perennial kidney cotton also escapes extinction by producing nearly all its blossoms at one season. In the central plateau region of Salama and Rabinal another perennial variety is cut back annually to the ground. New shoots spring up and the new crop is set within a short time, while the plants are still small enough to be cared for by the chickens and turkeys.

Another of these protective adaptations proves to be of such potential significance as to call for announcement in advance of a detailed report. The issue is nothing less than that the cotton plant, in some of its varieties, has finally developed a practical means of resisting and destroying the weevil larvæ. The process is in the nature of a varietal characteristic subject to increase by selection. The efficiency of the adaptation is such that a variety in which it appeared uniformly would afford no opportunity for the weevil to breed, and would thus be a means of exterminating it.

The facts are simple and have been thoroughly established during the department's entomological studies of the weevil for the past decade, but they have not been interpreted as a protective adaptation, nor as a character subject to further selective development. Messrs. Hunter and Hinds have reported* that in some instances as high as 41 per cent. of the boll-weevil larvæ fail to develop, as a result of what they have termed a 'gelatinization' of the tissues of the young bud or 'square.'

In the later stages the injured buds often appear as though filled with a structureless exudation, and it was not unnaturally supposed that the abnormality was the result of some disturbance of nutrition, or of bacterial infection. The material failed, however, to yield cultures of bacteria or to respond to experiments with fertilizers. The opportunity of examining the earlier stages of the phenomenon show that the conditions are far less abnormal than have been supposed, and that the 'gelatinization' is simply the result of very active growth or proliferation of the loose tissue of the tube or column, which in the flowers of the mallow family surrounds the style and bears the stamens.

The usual program would be for the young squares to fall to the ground when the larva has hatched and begun to eat out the pollen of the young bud. Proliferation involves the opposite procedure. Instead of ceasing to develop, the soft tissues of the staminal tube are stimulated in a manner analogous to that by which galls and other vegetable excrescences are formed. The cavity eaten out by the larva is filled and the little miscreant is either smothered in paste or, more likely, starved by the watery tissue which is certainly no equivalent for the highly organized protoplasm of the pollen, the normal infant-food of the young larva. But whatever may be the actual cause of death the practical fact is that the larva is killed, and apparently in every instance in which proliferation occurs.* A very little of the new tissue may be effective. When the cavity eaten out by the larva is small it is often neatly plugged by the new growth, and the flower may develop with no very great distortion, though the corolla generally shrivels up before reaching more than half the normal length. The young boll is not always

* Bull. 45, Bureau of Entomology, U. S. Dept. Agriculture, p. 96, 1904.

* In a few cases living weevil larvæ were found in squares which gave evidence of gelatinization, but there was always a second puncture from the outside, indicating that another egg had been deposited.

blasted, though it is often small and irregular in shape, perhaps as a result of deficient pollination. The stigma sometimes projects from the injured flower and might be fertilized normally, but in other instances the withered staminal tube and corolla remain closely wrapped about it, so that pollen could scarcely have entered. It would not be surprising if the more rapid and persistent growth which favors the new protective tissue were also accompanied by a tendency toward parthenogenesis. Or it may be that the irritation resulting from the presence of the larva stimulates the ovary as well. Moreover, proliferation is not confined to the bud; the same or a closely similar formation of tissue sometimes appears in the bolls, when these have been attacked by the weevils.

It is thus not merely a coincidence that the proliferation is most frequent in the quick-growing early varieties of cotton which are now prized in Texas as the best means of securing a crop. The weevil has conducted, as it were, a selection for rapidity of growth and early fruiting, and a further accentuation of vegetative energy has introduced the new protective habit. The destructive insect has, in effect, overreached itself, and induced a condition which with man's assistance may accomplish its own destruction.

It is not easy to conjecture any means by which the weevil could survive the general planting of a variety of cotton having proliferation as a constant character. If only the squares would 'gelatinize' the weevil might develop an instinct of postponing the egg-laying period until the young bolls could develop. The advantage might be partly temporary, though it would take many years for the weevil to meet the new demand, and it could never reach its present destructiveness because the delay of the breeding season, even for a week or two, would be an effective handicap, particularly if the weevils should continue to waste most of their ammunition on the squares, as they probably would.

How long it will take to secure a completely resistant cotton by selection can only be conjectured, since it is not known as yet how constant a character proliferation is in the plants which possess it. To lose no unnecessary time is, of course, of the greatest practical importance, not only for the industry at large but especially for the sake of the growers of the long staple cotton in South Carolina and Georgia. The longer season required by the Sea Island cotton will render entirely ineffective the cultural expedients by which a part of the crop of the upland varieties can be saved from the weevil; if the insect be permitted to reach the Atlantic coast Sea Island cotton will soon become an agricultural tradition.

This change of view regarding the nature of 'gelatinization' greatly alters the prospect of finding in tropical America a variety of cotton resistant to the weevil, a hope which seemed to be lessened by the discovery of the kelep or Guatemalan cotton-protecting ant. It is by no means impossible that varieties already exist in which proliferation has become a fixed character, and if not it will still be highly desirable to secure those in which the tendency is most strongly pronounced. In the ant-protected variety of eastern Guatemala, proliferation takes place very frequently, at least in the bolls, and the plant has other desirable features of quick, determinate growth and early bearing which may make it of value in Texas. It has the good qualities of King and other related varieties in accentuated form, though with a longer staple.

The dwarf Guatemalan cotton represents, as it were, the highest known development of the upland type. Even the annual character which has been looked

upon as a result of cultivation in temperate climates is a further instance of protective adaptation long ago secured in the tropics by the unconscious selection of the Indians. It was from the Central American region, evidently, that the other upland types came, but they represent an earlier stage of development, or have deteriorated because selection for resistant qualities has been relaxed in regions where the weevil was absent, as in our southern states. Other things being equal, the Indians would undoubtedly prefer the perennial 'tree' cottons, which continue to be cultivated in Mexico and Peru in localities so arid as to exclude the weevils, though it is not certain that they exist in Peru. Possibly there has never been a connected series of agricultural communities along which the weevil could follow into South America; the pest might never have reached the United States if cotton culture had not been extended into southern Texas.

But even if the varieties already known in Texas were to be utilized as the basis of selection, it is by no means beyond the limits of probability that a resistant, regularly proliferating variety could be secured within a decade, or even within five years, since cotton has been found to respond rather promptly to selective influence. The urgency of the matter would certainly justify an extensive campaign of selection, the problem being to find among the millions of plants which will be grown next season, some which possess in the highest degree the tendency to proliferation, and to secure seeds from them. The task, however, is peculiar, and more difficult than such experiments usually are, because there is little or nothing in the way of an external clue to the desired character. It may be necessary to cut open each infested square in succession to make sure that the plant is allowing no weevil larvæ to develop. And after the most promising plants have been located it may be possible to obtain seed from them only by artificially protecting them from the weevils. Otherwise the best stock might be lost if the weevils were very abundant. Indeed, this suggests a reason why 'gelatinization' has not become a fixed character already. Selection thus far has only been in the direction of proliferation in the bolls, since the proliferation of tissue in the buds would give a particular plant no advantage over its neighbors in the matter of seed production. It would enjoy no immunity from subsequent attack because it had not allowed any weevils to reach maturity. Weevils from other plants would continue to come to it, and the chances of ripening seeds would not be increased. There has been, in other words, no selective inducement for 'gelatinized' buds to become a uniform character except as they might be correlated with 'gelatinized' bolls, in spite of the fact that for killing the weevil proliferation in the buds is more important than that in the bolls.

These considerations reveal still another episode of evolutionary history, and may explain why it is that the variety protected by the ants, and the other 'upland' types which have originated in the same region, have the additional protective adaptations. It was only where the ants protected the cotton and thus perpetuated it as a field crop that these other considerations could have a cumulative effect. The other adaptations by which the tree cottons have maintained a desultory existence are of suggestive interest, but of apparently little practical importance, since no field culture of a perennial cotton seems to be maintained in any weevil-infested district.

In eastern Guatemala the cultivation of cotton as a field crop is strictly limited to localities suited to the ants, where they exist in such numbers as to give practical

protection. In Texas, however, cotton is grown under a great variety of conditions. The climatic vicissitudes of heat and cold, drought and flood are many times as great as in Guatemala, so that notwithstanding the unexpectedly great adaptability of the kelep it can not be expected to thrive equally well in all parts of the state, any more than does the weevil. Even if it be found that the ants can thrive, breed and establish new colonies in Texas, they will probably require many years to take full and effective possession even of the more favorable localities of this vast agricultural empire. Such a mitigation of the weevil's injuries would be, of course, of great practical value, and the work of the ants in destroying the larvæ of boll worms and leaf-worms might be only slightly less important in some districts. If, however, the hope of exterminating the weevil is to be cherished, or that of staying its ravages before it has laid the entire cotton industry of the South under tribute, there would seem at present to be no other alternative than to secure by discovery or development, within the next few years, a variety of cotton in which the larvæ of the boll weevil can not mature.

The present brief outline of the results of our study of cotton in Guatemala may be summarized by saying that the tendency to rapid growth and early fruiting, the large extrafloral nectaries which attract the ants, and the proliferation of the tissues of the young buds and bolls which kills the weevil larvæ, are protective adaptations, developed as a result of long contact between the cotton plant and the boll-weevil. The proliferation is not a mere pathological abnormality, but represents a definite evolutionary tendency, capable of further increase by selection. If this interpretation of the facts be correct it affords an intimation of a successful solution of the weevil problem by means of a resistant variety of cotton.

O. F. Cook.

Washington, November 4, 1904.

SCIENTIFIC BOOKS.

Dr. J. Frick's Physikalische Technik oder Anleitung zu Experimentalvortragen sowie zur Selbstherstellung einfacher Demonstrationsapparate. Siebente vollkommen umgearbeitete und stark vermehrte Auflage von Dr. Otto Lehmann. Friedrich Vieweg und Sohn. 1904. Pp. xxiii + 630.

The previous edition of this well-known standard work appeared in 1890–5 and consisted of two volumes, one of 725 pages, the other of 1,054. It is most interesting to note that there exists such a demand for a book of this character as to encourage the publishers to undertake the present seventh edition on such an enormous scale. This is to consist of two volumes; and of these the first part of the first volume only has so far appeared, having been published during the past summer. This is a volume of 630 pages and is illustrated with over 2,000 cuts. The scope of the present work as compared with previous editions may be estimated when it is noted that the subject matter contained in the volume under review had devoted to it in the last edition only 132 pages and 65 cuts.

As the title of the work indicates, it has a twofold object: one to suggest suitable experiments for class demonstrations, the other to give accurate instruction in the use of instruments, tools and technical methods. The subtitle of the first part of the first volume is 'The Rooms of a Physical Laboratory and their Equipment, together with an Introduction to the Use of the Latter.' There are five chapters: (1) 'Physical Demonstrations and the Laboratory Building'; (2) 'The Large Lecture Room'; (3) 'The Preparation Room and the Smaller Lecture Room'; (4) 'The Rooms for Apparatus and Assistants'; (5) 'The Rooms for the Mechanician and Janitor.'

There are numerous subdivisions of the chapters and full information is given in regard to almost every conceivable detail.

Methods of equipment of the lecture room with all kinds of power, and with water, gas, electricity, steam, etc., are fully discussed. Much information is given in regard to making rooms fire-proof and sound-proof; in regard to heating and ventilation; in regard to clocks, lighting, wardrobes, etc. All this is done with the utmost attention to details, and should prove of great assistance to architects, as well as to those responsible for the design and equipment of the laboratory.

In the chapter devoted to the description of the preparation room much extremely valuable information is given in regard to what may more strictly be called 'physical technique,' such as methods of working with leather and paper, glass-blowing, enameling, exposing and developing photographs, soldering of all kinds, and the use of various cements and waxes. This part of the book will, beyond a doubt, be of the most value to the worker in physics. Under suitable heads information of the fullest character is given in regard to the use of the lathe, of the forge, of the carpenter's bench, etc.

The fact that no detail, however insignificant, has been overlooked by the present editor of the book is shown by the inclusion in it of information concerning methods of tying knots, of pulling nails, of using even the simplest tools; and illustrations are given of such instruments as a crowbar, a hammer, a rubber glove and an oil-can. It may well be questioned whether such richness of detail is essential or advisable, but with a suitable index to the volume this ought to offer no serious objection. The need of an index, which is promised for the end of the first volume, is all the greater owing to the scanty information given by the table of contents, and to the fact that descriptions of many instruments are given in places where one would not expect to find them. Thus, under the heading 'Room for Delicate Work' is found the full description of Doleczalek's electrometer, of wire gratings and of the bolometer. These details may very well be given at this point of the book, as illustrations of the use of certain rooms in the laboratory; but without a complete index one might well search in vain for information.

The present edition of this great work is incomparably better than any of the previous ones. The illustrations are more numerous, and the letter press more detailed. Special attention is given to pieces of apparatus of recent design, and all the latest improvements are mentioned; references are made, when possible, to the historical development of various methods and instruments, but obsolete forms are not described. Full information is given as to places where every piece of apparatus mentioned, every tool and every machine, may be purchased, and the prices of both instruments and supplies are indicated.

The value of a work like the present one to every director of a laboratory, and to almost every worker in physics, is well shown by the fact that a seventh edition is now in demand, and so it need not be emphasized in this review. This present work is the most complete of its kind and gives the necessary information in the most convenient form possible. The only drawback to its general use comes from the fact that the publishers have seen fit to use German type instead of Roman.

J. S. AMES.

The Industrial and Artistic Technology of Paint and Varnish. By ALVAH HORTON SABIN, M.S., chemist for Edward Smith and Co., New York. New York: John Wiley and Sons. Pp. 372. Price, $3.00.

The work opens with two entertaining chapters upon the history and origin of varnish; these are followed by a description of the materials used in varnish and of its manufacture.

Especially noticeable are the parts treating of oils, paints and lacquers in China and Japan. The reviewer knows of no place where an equally interesting and instructive account of these Oriental arts can be found.

The specific value of the work consists in the attention paid to the protection of metals against corrosion and to water pipe coatings; these detail some experiments made upon large plates of steel and aluminum protected by various paints and varnishes when exposed to sea and lake water. These have not been

previously published and discussed in such a connected form, and are alone well worth the price of the book. Not less interesting and valuable are the portions devoted to antifouling paints, carriage and house painting and furniture varnishing.

Being a treatise on the industrial and artistic technology one scarcely expects to find much chemical information; there are, however, excellent chapters on the oils, particularly one on linseed oil by Dr. McIlhiney. It would have materially aided the chemist to have found an equally good and complete description of the gums used in varnish manufacture.

Throughout the entire work, one can not help being impressed with the wide practical experience of the author in the technology of paints and varnishes, and particularly with their applications.

The work should be in the hands of the architect, whether engaged in the erection of sky-scrapers or summer houses, of the civil engineer, having to do either with bridge or water works construction, of the naval constructor, and in fact of any one concerned with the preservation of wood or metal.

A. H. Gill.

GAUPP'S ANATOMY OF THE FROG.*

In preceding numbers of Science (Vol. VII., p. 463; X., p. 451; XV., p. 100) the earlier parts of this monumental work on the structure of the frog have received notice. The present part completes the whole, making a total of 1,738 pages, aside from preface, etc., entirely devoted to this one form. No other vertebrate, man excepted, has ever had such exhaustive treatment.

This concluding portion, 521 pages in all, is devoted solely to integument and sense organs, all treated in the same careful manner as the other systems, but, as would be expected, microscopic detail is emphasized here as in no other parts. Not only do we have a general account of the structure of the skin and its glands like that given in the first edition of the work (familiar in most laboratories in Hassal's translation), but we are given a good summary of the known facts, structural and physiological, of the color changes and details of the breeding-season changes in specific regions of the skin.

In treating of the sense organs each section is followed by a résumé of the development of each and an account of its functions. Thus in connection with the nose we have an account of the course of the air in the different parts of the nasal cavity, and the evidence to show that the frog is an 'air smeller' even when submerged. It is especially in the section pertaining to the ear that the largest proportion of new facts are given, since Dr. Gaupp has made certain parts of the otic region peculiarly its own.

In conclusion, we may say that the work is one which must be in every laboratory, and while we can hardly expect the whole to be translated we wish that at least certain portions, like that on the central nervous system, were more accessible to our students. Congratulations must be extended to the author on the completion of such a vast amount of work.

J. S. Kingsley.

* A. Ecker's und R. Wiedersheim's 'Anatomie des Frosches auf Grund eigener Untersuchungen durchaus' neu bearbeitet von Dr. Ernst Gaupp. IIIte Abtheilung, IIte Hälfte, pp. 441–961 + xi. Braunschweig, 1904.

SCIENTIFIC JOURNALS AND ARTICLES.

The opening (October) number of Volume 11, of the *Bulletin of the American Mathematical Society* contains the following articles: 'On Developable and Tubular Surfaces having Spherical Lines of Curvature,' by Professor Virgil Snyder; 'Addition to a Theorem due to Frobenius,' by Professor G. A. Miller; 'On Self-Dual Scrolls,' by Professor E. J. Wilczynski; 'The Opportunities for Mathematical Study in Italy,' by Dr. J. L. Coolidge; 'Vector Analysis' (Review of Henrici and Turner's Vectors and Rotors, of Kelland and Tait's (Knott) Introduction to Quaternions and of Fischer's Vectordifferentiation und Vectorintegration), by Dr. E. B. Wilson; 'The Mathematics of Insurance' (Review of Loewy's Versicherungsmathematik), by Dr. Saul Epsteen; Shorter Notices (Seliwanoff's 'Lehrbuch der Differenzenrech-

nung'), by Dr. Saul Epsteen; Notes; New Publications.

The November number of the *Bulletin* contains the following articles: 'Report of the Eleventh Summer Meeting of the American Mathematical Society,' by Professors M. W. Haskell and H. S. White; 'Report of the October Meeting of the San Francisco Section,' by Professor G. A. Miller; 'The Foundations of Mathematics' (Review of B. Russell's Principles of Mathematics and Foundations of Geometry), by Dr. E. B. Wilson; Notes; New Publications.

The General Index of the first thirteen volumes of the *Bulletin*, 1891–1904, compiled by Dr. Emilie N. Martin, has just been issued as a separate publication. The 80 pages comprise indexes according to authors, works reviewed, and subject matter, the last classified according to the Répertoire bibliographique des Sciences mathématiques. There is also an index of all papers read before the Society since 1891.

THE October number (Volume 5, No. 4) of *The Transactions of the American Mathematical Society* contains the following papers:

F. S. MACAULAY: 'On a Method of dealing with the Intersections of Plane Curves.'

J. M. PEIRCE: 'On Certain Complete Systems of Quaternion Expressions, and on the Removal of Metric Limitations from the Calculus of Quaternions.'

L. P. EISENHART: 'Three Particular Systems of Lines on a Surface.'

E. J. WILCZYNSKI: 'On Ruled Surfaces whose Flecnode Curve intersects every Generator in two coincident Points.'

J. I. HUTCHINSON: 'On the Automorphic Functions of the Group (0, 3; 2, 6, 6).'

H. F. BLICHFELDT: 'A Theorem concerning the Invariants of Linear Homogeneous Groups, with some Applications to Substitution Groups.'

F. MORLEY: 'On the Geometry whose Element is the 3-Point of a Plane.'

G. A. BLISS: 'Sufficient Conditions for a Minimum with respect to One-Sided Variations.'

H. L. RIETZ: 'On Groups in which certain Commutative Operations are Conjugate.'

M. FRÉCHET: 'Sur les Opérations Linéaires.'

H. TABER: 'On Hypercomplex Number Systems (first paper).'

This number also contains: Notes and Errata, Volumes 1, 3, 4, 5; Table of Contents, Volume 5; Indices by subject matter, authors and numbers, Volumes 1–5.

The Popular Science Monthly for November opens with an account of 'The International Congress of Arts and Science,' by Wm. Harper Davis, illustrated by many portraits of those who participated therein. The rest of the number is devoted to addresses delivered at the congress and includes 'Present Problems of Inorganic Chemistry,' by Sir William Ramsay; 'The Light of the Stars,' by E. C. Pickering; 'Fundamental Concepts of Physical Science,' by Edward L. Nichols; 'The Methods of the Earth Sciences,' T. C. Chamberlin; 'Utilitarian Science,' by David Starr Jordan, and 'The Evolution of the Scientific Investigator,' by Simon Newcomb. In the 'Progress of Science' the editor briefly reviews the work of the congress and incidentally queries whether or not the amount accomplished justified the expenditure. The papers read and meetings held were, after all, but a small part of the good accomplished. As in almost every gathering of scientific men, the real good was the bringing together and meeting of those who participated, and particularly the privilege enjoyed by the younger men of meeting the acknowledged masters in science. Papers may be read at any time, but the men who present them are often names only and devoid of the personality that results from actual acquaintance.

The Museums Journal, of Great Britain, for October, contains for its leading article an account of the 'Norwich Castle Museum,' by Thomas Southwell. The interest of the number, however, centers around a letter by E. Ray Lankester, on 'Museums and Nature Study,' in which he points out most admirably some of the purposes for which museums and their scientific staff exist. In this connection it may surprise some to learn that the British Museum has no lecture hall.

Another most important article is a communication from Luca Beltrami, included under the title 'A Mediæval Vestment,' in

which he draws attention to the ethics in the case of the cope of Nicholas IV., which was abstracted from the cathedral at Ascoli and has been purchased by J. Pierpont Morgan.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

DURING September and October the American Mathematical Society held three several meetings. Of these the first in interest and importance was the eleventh summer meeting, held at St. Louis on September 16–17, thus immediately preceding the congress of arts and science of the Louisiana Purchase Exposition. Nearly forty members of the society attended this meeting, and there were present also by invitation Professors Gino Fano, of Turin, who brought greetings from Italian colleagues, and Henri Poincaré, of Paris, who read a paper on 'Closed geodesics on a closed convex surface,' a subject which had attracted his attention on account of its importance in connection with the discussion of trajectories in celestial mechanics. A detailed account of the meeting will be found in the November number of the *Bulletin* of the society, which also contains a report of the meeting of the San Francisco section at the University of California, October 1. At the latter meeting the program included a conference on recent investigations on the teaching of elementary geometry.

The one hundred and twentieth regular meeting of the society was held at Columbia University on Saturday, October 29, with an attendance of twenty-four members. President Thomas S. Fiske occupied the chair. Nominations of officers and members of the council to be elected at the annual meeting in December were adopted and ordered placed on the official ballot. The committee on the financial support of the *Transactions* reported a favorable outlook, several universities already having promised assistance in the form of a subvention. The expense of publishing the *Transactions* has been $2,000 per annum, of which amount ten universities have thus far contributed one half, the balance being met by the society and by returns from subscriptions and sales. Committees were appointed to consider measures for providing for the increasing burden of administration and to audit the treasurer's accounts.

The following papers were read at the October meeting:

DR. EDWARD KASNER: 'Contact transformations and related systems of curves.'

DR. MAX MASON: 'The doubly periodic solutions of $\Delta u + \lambda A(x, y)u = f(x, y)$.'

PROFESSOR E. B. VAN VLECK: 'A proof of some theorems on pointwise discontinuous functions.'

PROFESSOR HENRY TABER: 'Hypercomplex number systems.'

MR. J. C. MOREHEAD: 'Note on a theorem of Lucas on Fermat's numbers.'

PROFESSOR E. W. BROWN: 'On the completion of the new lunar theory.'

PROFESSOR VIRGIL SNYDER: 'Quintic scrolls having a tacnodal or an osculating conic.'

PROFESSOR G. A. MILLER: 'Groups of subtraction and division.'

The following new members have recently been admitted to the society: Mr. R. P. Baker, Union Academy, Anna, Ill.; Dr. W. H. Bussey, Evanston, Ill.; Dr. H. A. Converse, Baltimore Polytechnic Institute; Mr. A. M. Curtiss, State Normal School, Oneonta, N. Y.; Professor G. R. Dean, University of Missouri; Dr. E. L. Dodd, University of Iowa; Dr. Saul Epsteen, University of Chicago; Professor R. R. Fleet, William Jewell College, Mo.; Professor E. D. Grant, Michigan College of Mines; Mr. J. E. Higden, Shortridge High School, Indianapolis, Ind.; Dr. L. E. Karpinski, University of Michigan; Dr. O. C. Lester, Yale University; Professor Tullio Levi-Civita, University of Padua; Professor J. C. Lymer, Lawrence University, Appleton, Wis.; Professor W. F. Moncreiff, Winthrop College, S. C.; Mr. Arthur Ranum, University of Wisconsin; Mr. C. S. Sisam, U. S. Naval Academy; Miss Adelaide Smith, Huguenot College, Wellington, S. A.; Dr. Clara E. Smith, Yale University; Professor C. M. Snelling, University of Georgia; Professor Eduard Study, University of Bonn; Professor D. T. Wilson, Case School of Applied Sciences. The total membership of the society is now 480.

F. N. COLE,
Secretary.

AMERICAN CHEMICAL SOCIETY. NORTHEASTERN SECTION.

THE fifty-fourth regular meeting of the section was held Thursday evening, October 27, in the Lowell Building, Massachusetts Institute of Technology, with President W. H. Walker in the chair. About 135 members and guests were present. Dr. Harvey W. Wiley, chief of the bureau of chemistry, U. S. Department of Agriculture, gave an address on the 'Effects of Preservatives on Health,' in which he described the experiments made in Washington under his charge to determine the effect of boric acid and borax, when taken into the system daily with the food for a long period of time. The conclusion drawn by the lecturer was that the effect of the constant use of these preservatives was on the whole somewhat injurious, causing, in many cases, loss of appetite, headache, and resulting in a diminution of weight, and slight changes in the metabolism of phosphoric acid, nitrogen, fat, etc.

ARTHUR H. COMEY,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 588th regular meeting was held October 15, 1904, Past-president Dall in the chair.

The death since the last meeting of Messrs. A. Lindenkohl and F. G. Radelfinger was announced.

Mr. F. W. Clarke spoke on 'Chemistry at the International Congress of Arts and Science.' The papers read were of high character and on the chemical sides the congress was a decided success.

Mr. O. H. Tittmann gave a brief account of his work the past summer as one of the commissioners for 'The Demarkation of the Alaskan Boundary.' A strip of this line some 500 miles long by 20 to 30 miles wide had been surveyed by the phototopographic method in previous years, and the results had been mapped for the High Joint Commission in London; the findings of the commission had defined the boundary line, and the five field parties this summer were engaged in erecting monuments over a portion of it.

Mr. L. A. Bauer then described 'A Method of Disclosing System of Magnetic Forces Causing the Secular Variation of the Earth's Magnetism.' It was pointed out that until an analysis of the secular variation forces has been made in a similar manner to that employed by Gauss for the permanent magnetic field, it is useless to theorize as to the cause of the secular variation. Such an analysis has been undertaken by the Department of Terrestrial Magnetism of the Carnegie Institution, an exhaustive compilation and discussion of the available data being made for the entire earth. Some preliminary results of the analysis as applied to certain well-surveyed areas, as, for example, the United States, were given in order to show the fruitfulness of the methods employed. The system of magnetic forces causing the secular variation in the United States during the period 1885–95 operated in opposition to that of the permanent field, *i. e.*, it acted as a *demagnetizing* system of magnetic forces directed opposite to those of the earth's permanent magnetization.

CHARLES K. WEAD,
Secretary.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

DR. ALES HRDLICKA presented a photograph of a recent Crow burial in Montana, showing a well-covered body lying on a platform elevated on four-forked poles.

Dr. Hrdlicka also showed two crania with the same variety of intentional deformation, one from Peru and the other from Vancouver Island. The Peruvian skull presents an extreme degree of deformation, which was produced by surrounding the infant's head with tightly drawn bandages. Strangely enough, Peru and a portion of the northwest coast of North America, including Vancouver Island, are the only localities where this rather complicated form of mutilation is found on the American continent.

Dr. Swanton gave a short account of the Tlingit Indians of Alaska whom he has recently studied. There were formerly about fourteen local groups of these people, divided into numerous families and, socially, into two exogamous clans, or sides. A small division

was found which belongs to neither of these latter. Anciently each group had at least one winter town, but scattered among many camps in spring and summer. All law was based on the principle of 'retaliation,' and they believed in a multiplicity of spirits who communicated with men through numerous shamans. The Tlingit and Haida languages are similar in form and are probably genetically related.

Hon. Ainsworth R. Spofford, of the Library of Congress, who has recently paid a visit to Spain, read a paper entitled 'The Spanish Race of To-day.' It was replete with historic data, and references to scenery, language and manners and habits of the natives. The characteristics of the people were shown to be politeness, observance of etiquette, and sobriety. The climate varies from cold in the north to heat in the south. This has marked influence upon the people, those of the north being austere, while those from the south are lively and pleasure-loving. Though illiteracy is common, the natives are shrewd; agriculture is neglected, lotteries are fostered by the state, and begging is a national trait. The mule is the beast of burden, there being 1,500,000 of them to 400,000 horses.

J. D. McGuire,
Acting Secretary.

THE TORREY BOTANICAL CLUB.

The club met at the New York Botanical Garden, October 26, 1904. The meeting was called to order at the usual hour, Dr. D. T. MacDougal occupying the chair.

The first paper on the scientific program was by Dr. N. L. Britton on 'Notes on the Flora of the Bahamas.' The speaker, in continuation of previous explorations, which were reported in *Torreya* for July, recently spent five weeks in the Bahamas, principally on the Island of New Providence.

About 950 native and naturalized species have been reported from the Bahama Islands, an unexpectedly small number, in part accounted for by the fact that most of the land does not reach an elevation of more than 25 feet, although on one of the outer islands a height of 400 feet is recorded.

The flora is remarkable in the very unequal distribution of species, some being recorded from only one key. It is related to that of northern Cuba, extreme southern Florida, and in a lesser degree to that of Haiti. While the collections have as yet received only preliminary study, it is probable that ten or twelve new species will be founded on forms formerly thought to be identical with Cuban or other West Indian species.

The speaker gave a brief review of the flora, noting among other facts the presence of but five Gymnosperms—a *Pinus*, three *Zamias* and a *Juniperus*. The lower Monocotyledones are but poorly represented.

Of the grasses about fifty species were collected; these have not been studied, but it was noted that they show characteristic forms in each of the plant associations of the island. One of the most interesting is the climbing bamboo, *Arthrostylidium capillifolium* Griseb., whose light green color gives a characteristic tinge to the coppices. Seventeen species of sedges, none new, are to be added to the published flora of the islands. The palms are abundant and interesting, five species being reported. There were eight or ten species of bromeliads, about twenty-five orchids, and four or five figs reported. Among the Nyctaginaceæ there are two trees heretofore referred to *Pisonia* but evidently not properly referable to that genus.

It was noted that most of the trees of the islands do not reach as great a height as they do in the Florida 'hammocks.' A water-lily, in habit resembling a small *Nelumbo*, and heretofore referred to *Castalia ampla* is of special interest. The coastal thickets furnished a beautiful species of *Parthenocissus* with scarlet pedicels. Among the abundant types were many Malvaceæ, Celastraceæ, Euphorbiaceæ, herbaceous Papilionaceæ and shrubby and arborescent Mimosaceæ. Numerous photographs and specimens were exhibited.

The second paper was by Dr. Marshall A. Howe, who spoke on 'The Algæ of some European Herbaria.' This was a general account of a trip undertaken during the past summer for the purpose of seeing and studying the historical types of American marine algæ pre-

served in certain foreign herbaria. The first stop was at Trinity College, Dublin, where are found the collections of W. H. Harvey, author of the 'Nereis Boreali-Americana,' and of several shorter papers on American seaweeds.

In England, the three principal herbaria visited were those of the British Museum, the Linnæan herbarium and that of the Royal Botanical Gardens at Kew.

In France, a few days were spent at Caen, in the department of Calvados, where are preserved the collections of several students of seaweeds, such as Roussel, Lamouroux, Chauvin and Lenormand. Of these, the herbarium of Lamouroux is of chief interest, containing the materials from which thirty or more American species were first described.

At Paris the collections of Montagne, of De la Pylaie, and of Decaisne, which are in possession of the Muséum d'Histoire Naturelle, were those chiefly studied, though a collection of Guadeloupe algæ issued by Mazé and Schramm was also examined. The next stop was Eerbeek, Holland, for the purpose of seeing certain originals of Kützing, now owned by Madam Weber-van Bosse.

In Oldenburg, Germany, a few types of Roth, and in Copenhagen a few of Lyngbye and of Vahl were seen. The longest stay of the trip was made at Lund in southern Sweden, where a month was spent in studying the numerous American originals of the two Agardhs, father and son, who were actively engaged in describing marine algæ for a period of ninety years. Specimens were taken to Europe by Dr. Howe for comparisons with the types.

Photographs were obtained of about three hundred of the types examined and these are expected to prove particularly useful, especially as many of the species have never been figured.

The next regular meeting falling on the evening of election day, on motion the club adjourned to the last Wednesday in November.

EDWARD W. BERRY,
Secretary.

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE eighth regular meeting of the Society for Experimental Biology and Medicine was held on Wednesday evening, October 19, in the demonstration room of the Department of Physiology of Columbia University at the College of Physicians and Surgeons. Dr. S. J. Meltzer presided.

Members present.—Burton-Opitz, Calkins, Davenport,* Ewing, Flexner, Gies, Hiss, Lee, Levene, Levin, Lusk, Mandel, Meltzer, Park, Richards, Salant, Wadsworth, Wallace, Yatsu.

Members elected.—J. G. Adami, R. A. Hatcher, Yandell Henderson, G. N. Stewart, C. G. L. Wolf.

Scientific Program.†

1. *The accommodation of the eye,* with demonstrations. Professor THEODOR BEER, of the University of Vienna.

Professor Beer called attention to the facts that, in an eye constructed as a 'camera obscura,' accommodation is effected by (1) change of curvature of refracting surfaces, principally the lens, and by (2) change of distance between refracting mediums and image screen, principally distance between lens and retina. Change of curvature of refracting surfaces is always in the direction of *increase* of curvature. It may be observed in mammals, birds and reptiles (very few snakes). Experiments were carried out before the society to show the increase of curvature of the lens in the eye of the water turtle. Accommodation by change of distance between lens and retina is effected, for objects at a distance, by (*a*) a movement of the lens toward the retina or by (*b*) a movement of the lens toward the cornea. The former is shown in cephalopods and fishes, the latter in amphibia and most snakes. In the eye of the fish there is a muscle, *Musculus retractor len-*

* Non-resident.

† The abstracts given in this account of the proceedings have been greatly condensed from abstracts given to the secretary by the authors themselves. The latter abstracts of the reports may be found in current issues of *American Medicine* and *Medical News.*

tis Beer, which draws the lens toward the retina. In amphibia and most snakes, the lens is moved toward the cornea away from the retina by changes of the intra-ocular pressure.

2. *Preliminary communication on the composition of the liver after subcutaneous injections of liver extracts.* P. A. Levene and L. B. Stookey.

Rabbits were treated with saline liver extracts. The autolytic powers of the livers of such animals were compared with the autolytic powers of livers from normal animals, and were found to be undiminished. The livers of the treated animals contained smaller proportions of nitrogen, but larger proportions of non-coagulable proteids, of non-basic nitrogen and of ethereal extract, than the livers of the control rabbits. Water and carbohydrate contents were unaffected by the treatment.

3. *Retransformation of negatively heliotropic animals (Gammarus pulex) into positively heliotropic animals by chemical means.* Jacques Loeb. (Presented by Simon Flexner.)

Professor Loeb recently succeeded in finding an instance of the transformation, by chemical means, of the sense of heliotropism in animals. He has observed that if one puts suddenly a large number of *Gammarus pulex* into distilled water or into common tap water, they all become at first very negatively heliotropic. These negatively heliotropic animals can be transformed instantly into positively heliotropic animals by the following substances: (1) many of the anesthetics of the fatty series; (2) many acids, except very weak ones like boric acid; (3) certain salts, like ammonium salts. The strengths of solution which effect this change instantly are, for example, ethyl acetate, $m/50$; ether, $m/6$; ethyl alcohol, $5/2m$; paraldehyd, $m/10$; hydrochloric, oxalic and acetic acids, $m/500$; boric acid, $m/10$; ammonium chlorid and ammonium hydroxid, $m/125$. Professor Loeb ascribes his results to chemical actions rather than to osmotic influences.

4. *Trypanosomes and bird malaria.* F. G. Novy and W. J. MacNeal. (Presented by Gary N. Calkins.)

Two genera of malarial parasites were studied—*Plasmodium* and *Hæmoproteus*—and four new species were distinguished, viz., *Plasmodium Vaughani, Hæmoproteus MacCallumi, H. Sacharovi* and *H. Rouxii.* The first is found in robins, the second and third in mourning doves, the fourth in sparrows.

The culture method is the best means of differentiating Trypanosomes as well as for detecting them in the blood.

Schaudinn's contention that *Halteridium* forms are but sexual phases of *Trypanosoma* is not confirmed, but, on the contrary, evidence is accumulated against it. For example, the culture method shows the existence at one time and in one culture of forms which Schaudinn described as *Halteridium* and as *Spirochæta* or Danilewsky's 'leucocytozoon.' One possibility of error in Schaudinn's results is that he worked with 'mixed cultures' in the mosquito.

5. *The gradual decrease in bacteria of the production of agglutinable substance.* William H. Park.

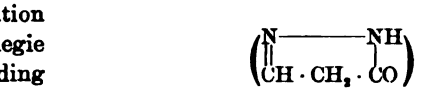
Dr. Park observed a diminution and finally almost a complete lack of development of agglutinable substance in bacteria grown in a serum rich in agglutinins and immune bodies. This observation is interesting both as showing a rapid variation in bacteria of essential characteristics and as possibly indicating one means of adapting themselves to resist destruction in the living body, since the bacteria which cease to produce agglutinable substance and probably, also, less substance with affinity for other anti-bodies, might be considered less vulnerable to these substances. Dr. Park's explanation of the process is that there are substances in the serum which attack certain parts of the bacteria, such as the agglutinable substance. With the increase of bacteria in the serum, those which produce the least of these substances are least inhibited and therefore develop most rapidly. When cultures are made from serum solution to serum solution daily, a gradual differentiation takes place until finally bacilli producing almost no agglutinable substance develop.

6. *Some Mendelian results in animal breeding.* C. B. Davenport.

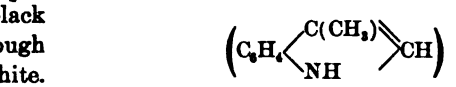
The essence of Mendelism in inheritance is its alternative character. In this it is opposed to blending inheritance (as in human skin color), which has been regarded as the typical sort of inheritance. At the Station for Experimental Evolution of the Carnegie Institution certain new cases of non-blending inheritance have already been found. Among sheep it appears from Dr. Alexander Graham Bell's records that the offspring of two black sheep are (probably always) black, although one or more of the grandparents were white. It looks as if black color (like albinism) might be recessive. Among canary birds it is found that, of the offspring of crested and of plain headed birds, some are crested and some are not. Poultry have been studied because of the numerous characters they exhibit. When a Japanese long tailed, clean legged cock was crossed on a white bantam hen, the two surviving offspring were highly colored like the father and had abundant feathers on the legs like the mother. The crested characteristic of poultry is peculiar, being sometimes dominant, and sometimes (apparently) blending with the crested condition when the cross is made.

7. *On the decomposition products of epinephrin.* JOHN J. ABEL and R. DE M. TAVEAN. (Presented by WILLIAM J. GIES.)

The empirical formula, $C_{10}H_{11}NO_3 \cdot \frac{1}{2}H_2O$, adopted by Professor Abel for that member of the epinephrin series which he has called epinephrin hydrate (the adrenalin of Takamine) is, at present, the subject of an acute controversy. In this report special attention was drawn to the fact that the $\frac{1}{2}$ H_2O of the above formula has always been regarded by Abel as *water of constitution* and *not* water of crystallization, as his opponents have apparently taken for granted. The basic substance, $C_3H_4N_2O$, which is obtainable equally from both forms of epinephrin, has been decomposed, by treatment with caustic potash, into ammonia (NH_3), methylamin ($CH_3 \cdot NH_2$), and methylhydrazin ($CH_3 \cdot NH : NH_2$). The last degradation product is of great importance in throwing light on the chemical constitution of the new base, $C_3H_4N_2O$. Its appearance, under the circumstances referred to, proves that the two nitrogen atoms of this base are directly combined one with the other, and suggests, among other things, for this base a ring structure such as is found in bodies of the pyrazolon



series. Small quantities of skatol



have been obtained on fusing epinephrin hydrate with caustic alkalies. Further investigation, particularly an analytic study of epinephrin hydrate prepared in an atmosphere of hydrogen, is in progress.

WILLIAM J. GIES,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE MEMBERSHIP OF THE AMERICAN ASSOCIATION.

THE writer was recently dining with friends, none of whom is engaged in scientific work in the narrower sense of the term. The American Association came up for discussion, and one of them said that he would like to become a member, but did not know how to arrange it. I said that I should be glad to nominate him for membership, and then asked the others if they would consent to be proposed for membership. There were in all seven; four consented to join the association, one was already a member, one took the matter under consideration and one declined. They were all surprised, so far as I remember, to learn that the dues were only three dollars and that SCIENCE is sent without charge to members. I venture to communicate this experience to SCIENCE because it seems to me that the conditions would be similar in any group of intelligent people. If each member of the association would ask two of his friends to join the association, at least one of them would be likely to accept, and the membership of the association would be doubled, much to the advantage of the association and the progress of science in America.

X.

AN ARTIFICIAL ROOT FOR INDUCING CAPILLARY MOVEMENT OF SOIL MOISTURE.

To the Editor of Science: The article in Science of October 27, 1904, page 566, under the above title calls for some comment on account of the fact that it does not, clearly and certainly follow, either from the evidence presented in the paper or from the conditions of the experiment, as stated, that the movement of soil moisture observed was in any way the result of capillary action. The subject of the paper is an important one, and perhaps a fuller statement of the conditions and observations will make the position taken by the authors tenable; but, from the evidence presented, it appears that the flow of water observed may have resulted solely from percolation, induced by the suction developed by the partial vacuum maintained in the filter chamber.

The authors state that 'When a tube of this kind is moistened, so that the pores are filled with water, and the tube is protected from evaporation, it can be exhausted to a pressure equal to the vapor pressure of water, and, if connected to a two-liter receiver, it will maintain that pressure for a day or more without sensible loss.' They also state that such 'A tube in good condition, when immersed in water and exhausted, will take up water at the rate of 50 grams per minute.' From these two statements it appears that the texture of the filter was sufficiently close so that, when wet, it was air-tight against a pressure of one atmosphere; but that when the capillary power or surface tension of the outer layer of the filter was rendered nil by immersion in water the flow into it was 50 grams per minute under the pressure which before gave no movement. It appears, therefore, that an essential condition of flow is the supersaturation of the outer wall of the filter, which, in effect, is equivalent to immersing it in water. It can hardly be assumed, however, from the evidence of the paper, that capillarity within the soil unaided is capable of supersaturating the wall of the filter where the soil is brought in contact with it and of maintaining it in this condition for days together. It is to be expected, however, that the placing of the outer wall of the filter in close contact with the soil did have the effect of practically augmenting the thickness of the wall, causing the filter to stand in the soil as a porous curbing to a well. When so placed, the capillary soil moisture may be expected to join with that of the wall of the filter, thus reducing, within the areas of good contact, the power of surface tension to withstand the suction from within; hence, along those lines, could be established a flow exactly as if the filter had been immersed in water, but purely through atmospheric pressure, capillarity taking little or no part in the movement. As the water escaped from the soil into the filter the reduced pressure would spread outward, and this would permit the soil air to sweep more water toward the filter and thus maintain the supersaturated condition about its wall until the soil moisture was so much reduced as to leave the soil open enough to permit air to come in contact with the filter; thus restoring, in effect, the condition of the filter described in the first quotation, with the wall only capillarily saturated and under which no flow took place. We do not feel, therefore, that the evidence which the authors present in the article referred to is sufficiently conclusive to warrant the views there expressed, or that they have succeeded in devising an artificial root which, in any essential way, can be said to represent or measure the natural movement of soil moisture in a soil toward an active root.

There is no doubt that if a method could be devised which would enable the rate of movement of soil moisture in the different soil types to be measured, under field conditions, an important advance could be made; but it is important to recognize that, even if it shall appear that the flow of water in the cases cited was due to capillarity, unless the method can be made capable of reducing the water lower than 17 per cent., in a soil whose maximum is 20 to 22 per cent., investigations made with it can have but a limited value. The force of this remark will be seen when it is pointed out that the lowest limit of moisture, in the soil experimented with, at which the flow ceased, was at least not lower than

the maximum amount the soil should contain, except for short intervals, in order to secure the best growth.

But even if the author's conclusions be not correct regarding the cause of the flow of water in the experiment, the line of investigation is important in that it has provided a means of securing water from field soil, perhaps, in a somewhat more concentrated condition than occurs in natural drainage and permits the sample to be taken where its history may be very definitely known; and it is to be hoped that they and others will apply the method in investigating the character of soil extracts thus obtained. We regard it extremely doubtful, however, that either the concentration or the composition of solutions so procured will be found to be the same as that which closely invests the soil grains or the root hairs at the same place and time. Certainly, if the movement is a capillary one, the observations recorded in the bulletin* on the 'Movement of Water-soluble Salts in Soils' indicate that very notable changes in the composition of the solution may take place as a result of the translocation. Our own observations also show that when only small quantities of some solutions are forced through such filters the concentration may be measurably changed.

F. H. KING.

MADISON, WIS.,
November 2, 1904.

HYBRID WHEATS.

TO THE EDITOR OF SCIENCE: In my original paper on hybrid wheats (Bull. 115, O. E. S.) the second generation of crosses between long-head varieties (*Triticum vulgare*) and club wheats (*T. compactum*) were divided into long, short and intermediate heads, these three types occurring in the proportion 1 : 2 : 1. Subsequent examination of later generations of these wheats, all of which continue to obey Mendel's law quite strictly, leads me to believe that the short head of the club wheats is really a dominant character, and that the apparent intermediate character of the heads of the heterozygotes of the several generations of hybrids is due to the greater vigor of the heterozygote individuals. It was found in the third and later generations that the long and intermediate heads could be separated without error, as shown by the purity of the long heads next year. But there were many small errors in separating the intermediate and short heads. If the latter separation had been perfect, the short-head type should have reproduced true to type. But in a majority of the plats supposed to contain only short heads, a few long and about twice as many intermediate heads were found, indicating that in most cases one or more intermediates had been selected with the shorts the previous year. When the seed of each plant was kept separate, this difficulty disappeared, each plant behaving either as a pure short head type or as an ordinary heterozygote.

One of the most interesting results which subsequent study of these hybrids has brought to light is the apparent effect of hybridization on the variation of single characters. For instance, the length of head of the long-head parent of the hybrid is fairly uniform, but in the hybrid this character varies between wide limits. The same is true of the length of the short or club heads. In the parent club variety the heads are fairly uniform in length; but in the pure short-head progeny of the second and later generations some of the heads were less than one fourth the length of the ordinary club heads. This induced variability of a character which has recently passed through the stage of what we may call heterozygosis probably accounts for the errors made in separating the intermediate and short heads above referred to. It is also of capital importance to the practical breeder. Those who are so situated as to attempt it will find an interesting problem in the effect of selection in fixing these variable characters, should the power of yielding large quantities of seed be rendered highly variable by hybridization, and should we be able to fix unusual yielding power thus induced, we could establish races of great economic value.

W. J. SPILLMAN.

U. S. DEPARTMENT OF AGRICULTURE.

* 'Investigations in Soil Management,' by the author, Madison, Wis.

GERMANY AND THE METRIC SYSTEM.

To the Editor of Science: In a recent issue of your journal a correspondent repeated the statement that the weights and measures of Germany were changed in 1870 from the old to the metric standards in a very short time; as he expressed it, it took "if not a fortnight, certainly only a few months, to make the 'masses' familiar with it, and about a year after the introduction there were but a few old and decrepit people that had been unable to master it."

This statement has frequently appeared in but a slightly modified form and backed by more or less high authority. Thus:

Lord Kelvin in the House of Lords, February 23, 1904: In Germany, France and Italy no inconvenience resulted from the introduction of the metric system, and there was no such thing as a complaint. The change in Germany occupied only two years. Sir W. Ramsay wrote: 'I was in Germany during the change there; it gave no trouble whatever and was recognized within a week.'

A witness before the Committee on Coinage, Weights and Measures at Washington, February 6, 1902: In talking to my head man about it—strange to say, we have one employee in a very important position, a German, who was in Germany in a somewhat similar position at the time the metric system was made compulsory there—he informed me that there is no real difficulty in making the change.

William Mauer, Secretary of the Germania Mills, Holyoke, Mass: The writer lived in Germany in 1871, when that country adopted the metric system, which gave great satisfaction, and the German population regretted at that time that they had not had the system long before.

Under any conditions such a radical change in the weights and measures of a country would be a cause of wonder. The very rapidity with which it is said to have been effected excites incredulity, which neither the eminence of the authorities who vouch for it nor a knowledge of the thoroughness of the rule of blood and iron by the Bismarckian régime can wholly remove. This doubt is further strengthened by testimony as to present conditions in Germany, of which a few examples follow:

Friedrich Frowein, Barmen, 1901, 'Kalkulator fuer Artikel der Textilbranche,' a handbook for textile workers. Gives complicated formulas for converting different standards, including the Prussian, Würtemberg, Baden and Bavarian ells. Gives calculations of cost, all involving a variety of standards. In the one for cotton tape there are the French inch, the English yard, the French line, the English pound and the meter.

Leipziger Monatschrift, October 31, 1902. A yarn calculation table based on the Vienna inch, English yard, English pound and the meter.

The same journal, July, 1903. An article on textile calculations in which are found the Saxon inch, English yard and pound and the metric standards.

Donat, 'Methodik der Bindungslehre,' Leipzig, 1901. Gives a list of standards in use in Germany which include the following: Leipzig, Bohemian, Berlin, Brabant, Vienna, English and French ells; English, Liepzig, French and Vienna pounds; Leipzig, English, Vienna and French inches.

Sixteen different systems of numbering yarn are in use in Germany based on the Berlin pound, the kilogram and half-kilogram, the English yard, the Berlin, Brabant and Leipzig ells and the meter.

Muenchner Allgemeine Zeitung, 1902. At the session of the tariff commission on June 24, 1902, the introduction of the metric system for cotton yarn came up for discussion. According to Abgeordnete Muench-Ferber, who is a manufacturer of cotton and woolen goods at Hof, Bayern, the introduction of the metric system would throw the German weaving industry into *heillose Verwirrung* because the German machinery is based on the English system.

In the light of this evidence as to the present conditions of German standards, those who seek the truth about the metric system have a right to ask for something more convincing than a repetition of the old story about a miraculous change in Germany thirty-four years ago. The evidence in conflict with that story can not be laughed to one side. The fact that the weights and measures of a great German industry are in a state of chaos to-day is proof that what we are asked to accept as the miracle of 1870 is, in fact, a myth of 1904.

Samuel S. Dale.

Boston, Mass.,
October 18, 1904.

VARIÆ AUCTORITATIS.

TO THE EDITOR OF SCIENCE: Mr. Emmons, SCIENCE (October 21, p. 537), gives Professor K. von Zittel's 'History of Geology and Paleontology,' p. 3, as his authority for the statement that 'Origenes reports of Xenophanes of Colophon that he had observed seashells on mountains, etc.' But Ritter and Preller, 'Historia Philosophiæ,' §140, *a* (p. 97), are more correct in attributing the statement to 'Hippolytus, *Ref. Hær.*, I., 14.' The Philosophoumena, or Adversus omnes Hæreses,' attributed formerly to Origenes, was proved by Bunsen in his 'Hippolytus and his Age' to have been the work of the latter. See Donaldson's 'History of the Literature of Ancient Greece,' Vol. II., p. 323, n. 1.

HENRY W. HAYNES.

BOSTON, October 29, 1904.

SPECIAL ARTICLES.

AN OVERLOOKED FORM OF STEREOSCOPE.

MODIFICATIONS of instruments, though in themselves not important, are often of interest as illustrating the variety of ways in which a given principle may be expressed in practise. This is notably true of the stereoscope, which as a practical instrument may be defined as any device that gives to each eye an appropriately different view and thus causes the eyes to combine two views with solidity. The oldest form of the apparatus, as well known, was devised by Sir Charles Wheatstone in the year 1838, and consisted of two mirrors set nearly at right angles and of two separate and appropriately different views of the object (in the early experiments always two mathematically constructed diagrams) carried at the ends of two movable frames. The serious disadvantage of the apparatus was noticed by the inventor himself and consisted in the fact that the two views, being separated, required a troublesome adjusting to secure an exact combination of images. A great improvement in the present form of the apparatus is due to Sir David Brewster, in which the views could be permanently mounted on a single card. It is rather interesting to note that the original discovery, to record that this advantage can be secured by a slight modification of the same principle which Sir Charles Wheatstone had so brilliantly demonstrated. It was, indeed, in reading his original account that the idea occurred to me of arranging the two mirrors in such a way that they would give proper reflections of two halves of the ordinary stereoscope card. The device will be easily understood from the accompanying diagram.

In using this device the eyes are placed just above the card which is turned with its back to the observer (Fig. 1). The slight inclination of the mirrors brings it about that each eye sees only one view of the card, while the

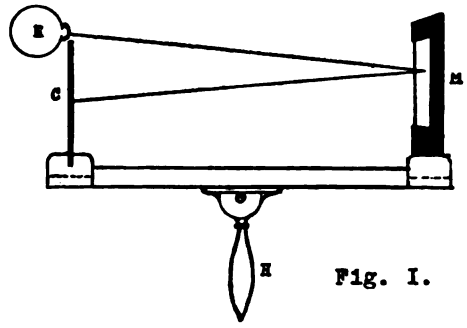


Fig. I.

FIG. 1. The apparatus as seen from the side. *E*, the eye; *C*, the stereoscopic card; *M*, the mirror; *H*, the handle.

combination is easily effected by a proper convergence of the eyes to a common meeting point beyond the plane of the mirrors. It is an incidental feature of this device that it dispenses with the necessity of the bridge or screen which in an ordinary stereoscope is necessary to prevent each eye from seeing both views. This is unnecessary because the image of the other view of the card falls outside of the field of vision of the one eye.* There is no advantage to be maintained for this form of the stereoscope; indeed, it has a disadvantage which in certain cases is slight

* This is practically the case; yet with a full-sized stereoscopic picture (3–3¼″) there will be a small portion of the outer edge of the left-eye view visible to the right eye, and *vice versa*. This is not seriously disturbing, and could be eliminated by appropriate screens.

and in others more serious, of presenting a mirror reversal of the views. The views likewise appear somewhat small, though it would be easy to introduce lenses to magnify them. But the interest in the device is merely in its simplicity and in the fact that so direct an application of the Wheatstone plan should have lain so near at hand for so long a time and, to my knowledge, not have been intentionally sought for or accidentally hit upon by the many experimenters who have contributed to the literature of the stereoscope. And it is also fair to add that the practical preparation of a pair of mirrors at this angle is not an easy matter, if one is desirous of eliminating the seam or line at their point of junction the presence of which to some extent mars the perfection of the stereoscopic effect. It seems, however, worth while thus briefly to record the possibility of a reflecting stereoscope which is adaptable to the ordinary stereoscopic card. As a laboratory device for illustrating the variety of applications of the stereoscopic principle, it may possess interest if not value.

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* In this diagram no account is taken of a minor discrepancy due to the fact that stereoscopic photographers have agreed upon a separation (and size) of the stereoscopic views (3–3¼″) greater than the interocular distance (2¼–2½″). As a result practically so much of the views as corresponds to the interocular distance becomes completely stereoscopic, the marginal portions not participating in the stereoscopic effect. Yet for

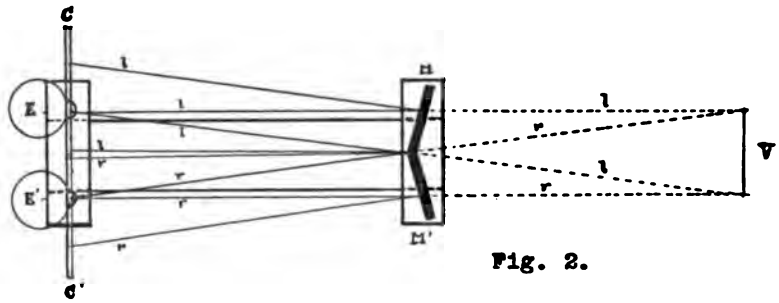

Fig. 2.

Fig. 2. The apparatus as seen from above. The letters as above: *V*, the combined view as projected by the eyes in stereoscopic vision; *r*, *r* and *l*, *l*, the paths of the rays in the right and left eyes from cards to mirrors and back.*

THE NATURE OF THE ACTION OF DRUGS ON THE HEART (PRELIMINARY NOTE).*

The analysis of the nature of the action drugs and certain inorganic substances solution on the isolated heart of vertebra

is rendered difficult by the intimate tion of the nervous with the musc ments in the heart, making it practi possible to study the effects of a so the nervous elements apart from th muscle, and *vice versa*. In the *Limulus* the relation of the nerve muscular elements is such that thi can be made. The heart of *Limul* prepared in a manner allowing the ation of the nature of the action tion: (1) On the ganglion cells, (motor nerves, (3) on the motor ner and the muscle.

I have shown elsewhere th the origin of the heart-beat muscular, and that the coord duction in the heart is effec nervous, not through the mu have some evidence that a si of the heart-beat obtains also and the crustaceans, and I that we shall have to revise cepted theory of the functio of ordinary views this discrepan none the less the effect in vi the limits of the interocular d more perfect.

* The experiments were perf the Mar Biological Laboratory, Wood as.

cells even in the vertebrate heart. This must necessarily lead to a revision of some of our views of the nature of the action of drugs and certain solutions on the heart, as these are based on the myogen theory of the heart-beat.

The preparation of the *Limulus* heart for the study of the action of solutions on the ganglion cells apart from their effects on the muscle is represented in Fig. 1. The ganglion or median nerve-cord is extirpated from the first and second segments, the lateral nerves being left intact. The removal of the nerve-cord removes the ganglion cells from that part of the heart. The extirpation of the nerve-cord in the first two segments diminishes the strength of the contractions in these segments, but it does not affect the rate of the beats or the strength of the contractions in the other parts of the heart. After removal of the ganglion from the anterior end of the heart the contraction of the muscle in these segments is caused by impulses from the ganglion cells situated in the nerve-cord of the fourth, fifth and sixth segments, these impulses passing forward to the muscle in the lateral nerves. The heart-muscle may now be removed for a distance of one centimeter or more in the region of the second pair of lateral arteries, leaving the two ends of the heart connected by the lateral nerves only. The anterior end of the heart is supported and connected with a recording-lever for graphic registration in the manner indicated in Fig. 1.

By the removal of the nerve-cord and the separation of the heart-muscle in the second segment the action of a solution applied to the anterior end of the heart can not be due to or complicated by the effects of this solution on the ganglion cells, care being taken, of course, that the solution does not touch the posterior end of the heart. But although this possibility is excluded, the solution applied to the anterior end of the heart may affect the rhythm of this part of the heart in either or all of these three ways: (1) It may act directly on the muscle, (2) it may act on the motor nerves and nerve-endings, or (3) it may act on sensory nerves and nerve-endings, the impulses being carried to the ganglion cells in the posterior part of the heart by means of afferent fibers in the lateral nerves. This would be a true reflex action. I have positive proofs of the presence of such a local reflex mechanism in the *Limulus* heart.

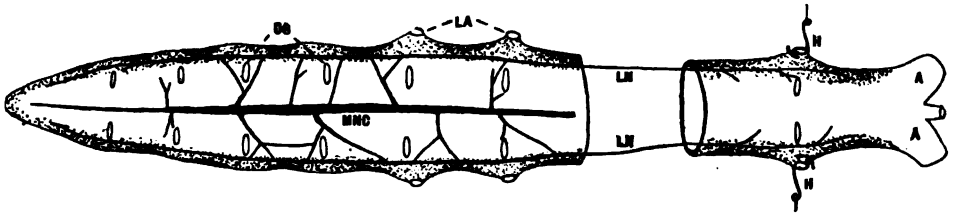

FIG. I. Heart of Limulus as prepared for studying the effects of solutions on the ganglion cells apart from that on the muscle. Dorsal view. *A*, anterior arteries; *LA*, lateral arteries; *LN*, lateral nerves; *MNC*, dorso-median nerve-cord or ganglion; *OS*, ostia; *H*, attachments for graphic registration of the contractions of the ganglion-free segments.

Conversely, if we apply the solution to the posterior end of the heart, that is, to the nerve-cord behind the lesion in the second segment, taking care that none of the solution reaches the isolated anterior end, the changes in the rhythm of the two anterior or reacting segments must be ascribed to changes in the activity of the ganglion cells due to the direct influence of the solution. It is possible to remove the greater part of the heart-muscle of the portion of the heart including the fourth to the seventh segments, leaving the nerve-cord, the lateral nerves and their main connections intact, without greatly disturbing the activity of the ganglion. The effects of the solutions on this isolated ganglion do not differ essentially from the effects

of applying the solution to the nerve-cord left in connection with the muscle. It is, therefore, probable that the solutions worked with act on the ganglion cells directly rather than indirectly by stimulation of sensory nerves or nerve-endings.

The alkaloids were dissolved in filtered plasma from the animal, or in sea water. Sea water is isotonic with the blood (Dr. Garrey) and is so slight a stimulant to the ganglion as to be almost neutral. On the heart-muscle I could not find that sea water had any effect.

The Effects of the Alkaloids on the Muscle.—Atropin, curare, pilocarpin and physostigmin of the strength of 1–100 in sea water or plasma have apparently no effect on the heart-muscle, the strength or the rate of the beats not being altered. Digitalin and nicotin of the same concentration produce extreme tonus contraction when applied to the ganglion-free segments. At a dilution of 1–1,000 digitalin applied to the muscle causes increased strength of the contractions, followed by a slight tonus. Nicotin produces tonus contraction even at the dilution of 1–2,000. Veratrin at the dilution of 1–1,000 causes an initial diminution of the amplitude of the beats, followed by strong tonus. At a dilution of 1–100,000 or 1–500,000 the amplitude of the beats is diminished, but no tonus contraction is produced. Aconite was worked with at a dilution of 1–100,000 and weaker; at that dilution it has apparently no effect on the muscle.

The Effects of the Alkaloids on the Ganglion Cells.—Atropin, curare, pilocarpin and physostigmin of the concentration of 1–100 (a strength which has practically no effect on the muscle) stimulate the ganglion cells intensely, the beats becoming very rapid and in some cases reduced to a minimum. The stimulating action of these drugs is best shown at a dilution of 1–500 or 1–1,000; at this concentration their effect on the nerve-cord is in the direction of augmenting the rate and the intensity of the nervous discharge from the ganglion cells, that is, the rate and amplitude of the beats in the ganglion-free reacting portion of the heart are augmented. The latent-time of the action of these drugs is very short, or from one half to five seconds, the shorter, the stronger the solution and the more excitable the nerve-cord.

Nicotin, digitalin, veratrin and aconite at the concentration of 1–100 stop the activity of the ganglion cells instantaneously. That this is a case of over stimulation or paralysis and not a true depressor action is shown by the fact that the stimulating action of these alkaloids is plainly evident on greater dilutions. Veratrin is the most intense stimulant of any of the alkaloids worked with. It must be diluted 1–1,000,000 or 1–2,000,000 in order not to kill or paralyze the ganglion almost instantaneously by over stimulation. At this great dilution it still causes great augmentation of the rhythm of the ganglion cells. Aconite stimulates the ganglion similarly at the dilution of 1–100,000 or 1–500,000; nicotin at the strength of 1–5,000 or 1–10,000; digitalin at the dilution of 1–1,000 or 1–2,000.

The latent period of the stimulation is short, or from one half to five seconds. At the dilution of one to two millions veratrin has often an initial depressor effect, which is invariably followed by acceleration or stimulation. Such an initial depressor action was not observed in the case of any of the other alkaloids.

None of these alkaloids proves fatal to the ganglion unless the application is long continued or their concentration great enough to stop the activity of the ganglion cells at once, and even in these cases the ganglion cells can usually be brought back to almost normal activity by continued bathing in plasma or sea water. After a bath of ten seconds in 0.5 per cent. nicotin, 1 per cent. digitalin, or 1/500 per cent. veratrin I never succeeded in restoring the ganglion.

The action of these alkaloids is, therefore, primarily on the ganglion cells in the heart rather than on the nerve-fibers or the muscle-cells. This is especially true of atropin, curare, pilocarpin and physostigmin, as these drugs have slight, if any, effect on the muscle and motor nerve-endings at the concentration of 1–100. And it is also true of the other alkaloids, or nicotin, digitalin, aconite and veratrin, for although these drugs act strongly

on the muscle even at a greater dilution than 1–100, their action on the nerve-cord is much more rapid and intense, and they, furthermore, act on the ganglion at a dilution which fails to affect the muscle. Part of the difference in the reaction of the muscle and the ganglion to these drugs is probably to be sought in difference in permeability of the muscle cell and the nerve cell.

The failure of these alkaloids (with the exception of veratrin) to produce initial inhibitory or depressor effects on the ganglion or the muscle is not due to the absence of an inhibitory nervous mechanism in the *Limulus* heart. Two pairs of inhibitory nerves pass from the posterior and dorsal surface of the peri-œsophageal ganglion to the median nerve cord on the dorsal side of the heart.

Before the action of these drugs on the ganglion and the heart muscle of *Limulus* was taken up an extensive study of the action of curare, atropin and nicotin on the molluscan and the crustacean heart had been carried out with the view of finding a drug that would paralyze the cardio-inhibitory nervous mechanism in these animals. None of the crustaceans or the molluscs allow a determination of the point of action of the drugs in the heart similar to the heart preparation of *Limulus*, but the reaction of the crustacean and the molluscan heart to these three alkaloids is identical with the reaction of the ganglion-free segments of the heart of *Limulus* on application of these drugs to the ganglion, which fact suggests that the relation of the ganglion cells to the heart-beat in these animals in no wise differs from that in the heart of *Limulus*.

We know of no drug which will paralyze the motor nerves or nerve-endings in the heart without destroying the excitability and contractility of the muscle. The heart-muscle responds to the stimulation of the nerves that pass from the nerve-cord to the muscle fifteen to twenty hours after the activity of the ganglion has ceased from exhaustion. After bathing the heart in one per cent. curare, one per cent. atropin, or one tenth per cent. nicotin for two or three hours the stimulation of these nerves is still effective. Nor does curare paralyze the motor nerve-endings in the body muscles of crustaceans and molluscs as maintained by some observers. In these animals curare acts like strychnia in the vertebrates, that is, causing primary excitation of the central nervous system, leading to tetanus and spasm and subsequent paralysis if the dose is sufficiently strong, but after such paralysis the body muscles still respond to stimulation of the motor nerves.

Alcohol in concentrations of 1–100 or 1–200 stimulates the ganglion cells both as regards the rapidity and the intensity of the nervous discharges.

The Action of Certain Inorganic Salts on the Ganglion Cells.—Barium chloride, rubidinum chloride, potassium chloride and sodium chloride stimulate the ganglion cells, the chlorides of calcium and cæsium depress the activity of the ganglion without primary stimulation.

When the nerve-cord is removed from the heart and the heart immersed in isotonic (⅝m.) sodium chloride the heart begins to contract more or less rhythmically after a latent period of from thirty to forty-five minutes. The addition of a small amount of calcium chloride prevents the development of this rhythm or stops it after it is once developed. The action of these salts on the ganglion-free heart-muscle of *Limulus* is thus identical with their action on the apex of the frog's or the tortoise's ventricle. The ⅝m. NaCl solution applied to the nerve-cord stimulates at once or after a latent time of less than a second. The stimulation of the ganglion cells appears in increased rate as well as amplitude of contraction, the amplitude of the beats becoming gradually diminished, until after ten to fifteen minutes the activity of the ganglion ceases completely. A small amount of calcium chloride counteracts the stimulating and subsequent depressor action of the pure sodium chloride.

Calcium chloride in isotonic concentration down to a dilution represented by one part $CaCl_2$(⅝m.) to twenty parts of sea water or plasma depresses the activity of the ganglion cells. This effect appears immediately on application of the solution to the ganglion.

When the strength of §m. is used the activity of the ganglion stops short at once, or a few diminutive beats separated by greatly prolonged diastoles precede the complete abolition of the activity. In weaker concentrations the depressor actions on the ganglion cells appear only in diminished rate and amplitude of the contractions in the reacting portion of the heart. After complete abolition of the activity of the ganglion by $CaCl_2$ the normal activity can be restored by bathing with plasma, sea water or isotonic sodium chloride solution. The resumption of functional activity is very gradual.

The action of calcium chloride on the ganglion is almost duplicated by that of cæsium chloride, only that the latter salt does not appear to depress quite as strongly as the former. The recovery of function is also somewhat quicker after the cæsium chloride bath. At §m. concentration cæsium chloride stops the activity of the ganglion almost at once, but in concentrations represented by one part of §m. of the salt to ten or twenty parts of sea water or plasma the depressor action appears in diminished rate and amplitude of the beats. The depressor action of this salt on the ganglion cells is further shown by its antagonism to the stimulating action of the alkaloids veratrin, aconite, niconite and digitalin. The addition of cæsium chloride to the solutions of these drugs greatly decreases their stimulating power, and bathing the nerve-cord in isotonic (or even weaker) solutions of the chloride after previous application of the alkaloid solutions quickly counteracts their stimulating effects.

The most powerful stimulants to the ganglion cells are the chlorides of barium, potassium and rubidinum. It is very difficult to work with the chloride of barium because of the fact that the barium is precipitated by the sulphates in the plasma or sea water. The isotonic solution of the salt can not, therefore, be diluted with either sea water or plasma, but a dilution is necessary to study its effect on the ganglion cells because the §m. concentration stops their activity instantaneously. This is due to over stimulation or paralysis. The barium chloride solution was diluted with a mixture of fifteen parts of §m. NaCl to one part § m. $CaCl_2$. This mixture proved nearly neutral for the nerve-cord. The addition of even one part of barium chloride to twenty parts of this mixture produced a marked augmentation of the rate and strength of the beats, which under the conditions of the experiments meant an augmentation of the rate and intensity of the nervous impulses reaching the muscle. Rubidinum chloride stimulates the nerve-cord at a dilution represented by one part of the §m. solution to twenty parts of sea water or plasma. The isotonic solution of the salt stops the activity of the ganglion instantaneously.

The §m. solution of the chloride of potassium stops the activity of the nerve-cord at once, just like the similar solutions of the chlorides of barium and rubidinum. Even at the dilution of one part of the potassium chloride solution to five parts of sea water or plasma the activity of the ganglion is usually arrested immediately, that is, without previous stimulation. That this is not a true depressor action is shown by the fact that at greater dilutions a strong stimulating action appears. At a concentration of one part §m. KCl to twenty parts of plasma the rate and strength of the beats are greatly augmented and this stimulating action is maintained for a relatively long time. Potassium chloride is a much greater stimulant to the nerve-cord than is sodium chloride. The concentration of the latter salt, represented by one part §m. NaCl to twenty parts of sea water or plasma, has no appreciable effect on the nerve-cord. Yet under some conditions potassium chloride appears to have a true depressor action. When the ganglion has been bathed for some time in a solution of one part § m. KCl to twenty parts of sea water and this solution replaced by sea water for some minutes, a reapplication of the former solution to the ganglion may result in a partial depression of the activity preceding the stimulation. The action of the potassium ion is thus a complicated one and in part determined by the condition of the ganglion cells.

Application of distilled water to the nerve-cord causes great acceleration of the rate of

the beats. This may be accompanied by an increased amplitude of the contractions for a few seconds, but the contractions become diminutive very quickly, and the rapid diminutive beats are followed by a prolonged diastole. The function of the nerve-cord is restored by plasma or sea water.

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QUOTATIONS.

THE COLLEGE YEAR.

THE beginning of the college year, a month ago, brought several interesting facts under discussion. For instance, in almost every college there was an increase in the number of students—in some colleges a very large increase. The demand for higher training keeps pace with the growth of wealth and population—perhaps outruns it, by mere physical measurement. Endowments and gifts to colleges continue to be made in ever-increasing sums. Yet the demands, especially of the larger universities, become greater every year. Columbia University, in New York City, for instance, has immediate need of more than two millions of dollars; and President Wilson, of Princeton, it will be recalled, formulated a plan of enlargement and improvement, last year, that calls for about twelve millions.

Dr. Alfred G. Mayer, a little while ago, put into concise form in SCIENCE the statistics of higher education in the United States, which show that the number of our universities and colleges in 1902 was 638, and the number of students, including graduate students, was 112,433. The number of colleges has increased by 50 per cent., and the number of students by about a hundred per cent., during the decade. But how small a part the college-bred are of the whole population is yet somewhat startling, for they comprise but one in every 700. There were twice as many teachers in 1902 as there were in 1889. The value of college property was multiplied by almost three; the endowment funds were two and a half times as great; gifts for other purposes were nearly three times as great; and the total income, exclusive of benefactions, was more than trebled. The number of books and libraries was doubled.

In spite of this increased prosperity, the average salary of teachers has probably declined. In one of our largest universities, the average, ten years ago, was $1,500. It is now only $1,257. In another one, the average was $1,454, and now it is $1,355. This low average has been caused by the engagement of an increasing number of instructors and other subordinate members of the teaching force. The salaries of the professors themselves have not declined, but the increasing proportion of college instruction is now done by subordinate members of the faculties. Sir William Ramsay, during his recent visit to the United States, made more than one plea for increasing the salaries of teachers of high grade.

College training, except in those universities that are maintained by the states, is yet paid for by rich men and dead men. The students, even at those institutions where fees are highest, pay not more than one third of the cost of the training that they receive. It is an industry that must yet be endowed—a fact that hints of its ecclesiastical history. In the perfect economic state, the state will pay for the training of all its children. But we need not yet bother ourselves about the ideal economic state. There is enough work for us to do in training well as large a number of capable youth as possible, at the expense of rich men, living or dead, at the expense of the state, or in any other way, if only enough youth be trained, and be trained well enough.—*The World's Work* for November.

BOTANICAL NOTES.

BOTANY AS A FACTOR IN EDUCATION.

IN a suggestive and helpful article in the October number of the *School Review* Professor J. M. Coulter discusses botany as a factor in education, noticing first its special function in secondary education, and then its general function as a representative scientific study. He says truly that since plants enter very largely into human experience their study 'must relate the pupil to his most common

experiences.' That plants 'reveal the fundamental laws of life,' that they 'are favorable for biological experiment' and that they present opportunities for the study of 'mass phenomena' (ecology, sociology), suggest the culture value of botanical study. As a representative scientific study botany may aid in the cultivation of the scientific spirit, which keeps close to the facts. In commenting upon this, the author says: "We are not called upon to construct a theory of the universe even upon every well-attested fact, and the sooner this is learned the more time will be saved and the more functional will the observing powers remain." "Facts are like stepping-stones; so long as one can get a reasonably close series of them he can make some progress in a given direction." And again, "As one travels away from a fact its significance in any conclusion becomes more and more attenuated. * * * A fact is only influential in its own immediate vicinity." Yet without some corrective training many a man starts with a single well-attested fact and from it constructs an elaborate system. "There is danger of setting to work a mental machine without giving it suitable material upon which it may operate. * * * It may not be that laboratory science in education is the only agency, apart from common sense, which is correcting this tendency; but it certainly teaches most impressively by object lessons which are concrete, and hence easiest to group, that it is dangerous to stray away very far from the facts, and that the farther one strays away the more dangerous it becomes, and almost invariably lends to self-deception."

THE BIRCHES.

Hubert Winkler's contribution to Engler's 'Pflanzenreich' is a notable addition to our knowledge of the birches and their allies. The family (Betulaceae) is divided into two tribes, Coryleae and Betuleae. In the first are the small genera *Ostryopsis* (1 species), *Ostrya* (2 species), *Carpinus* (18 species) and *Corylus* (8 species). In passing we notice that our American *Ostrya* is hereafter to be known as *O. italica* Scopoli, subspecies *virginiana* (Mill.) H. Winkler. In the second tribe the dominant genera *Betula* (38 species) and *Alnus* (17 species) are figured and described. That the treatment is conservative is shown by the fact that of the 84 species described but 9 are new! These are *Carpinus schuschaensis, C. londoniana, C. paxi, C. stipulata* (all from China), *C. grosserrata* (Persia), *C. hybrida* (Transcaucasia), *Betula luminifera, B. baeumkeri* (both from China) and *B. rosae* (Korea). One can not help admiring the author who has the ability to work over a group such as this, and not find it necessary to split up the common species. It is very certain that there are botanists who would have discovered a dozen valid (?) species in *Ostrya italica,* as many more in *Carpinus betulus* and still more in *Corylus avellana,* to say nothing of the possibilities in *Betula* and *Alnus!*

FORESTRY NOTES.

The 'Forest Manual' is the title of a useful booklet of sixty-four pages issued by the Bureau of Forestry of the Philippine Islands. It contains the forest act which took effect May 20, 1904; extracts from other acts and regulations of the Philippine commission in reference to the forests and their management; lists of native trees; directions for measuring, etc. The United States Bureau of Forestry has issued a bulletin (No. 52) on 'Forest Planting in Western Kansas,' prepared by R. S. Kellogg. After a year or so of careful investigation he says: 'Whatever may be the reasons for the absence of natural forests on the great plains, a close study of established plantations proves that, with an intelligent selection of species and proper care, planted trees can, to a considerable extent, be made to supply the deficiency.' The bulletin abounds in valuable suggestions as to the salvation of species and methods of planting. About twenty-five species are favorably mentioned, including honey locust, osage orange, Russian mulberry, green ash, red cedar, white elm, pines (Scotch and Austrian), black locust, hackberry, cottonwood, box elder, silver maple, black walnut, catalpa, etc.—Bulletin 46 of the Bureau of Forestry is devoted to the growth and management of

the basket willow (by W. F. Hubbard) and Bulletin 53 to the occurrence, soil-requirements and cultivation of the chestnut in southern Maryland. Both papers are well written and must prove very useful.—In the St. Louis World's Fair the Bureau of Forestry has made an outdoor exhibit including a demonstration forest nursery, covering about one fifth of an acre of ground. This valuable exhibit has been made still more valuable by the publication of a descriptive circular (No. 31) in which the plan of the work is clearly explained.—Professor Stanley Coulter and H. B. Dorner have published a handy 'Key to the Genera of the Forest Trees of Indiana,' based chiefly upon leaf characters. It makes a twelve-page pamphlet, which should be very useful to foresters and others interested in trees.—We may close these notes on trees by a reference to a curious book which has lately come to hand, 'The Tree Doctor,' by John Davy. In a book of 87 pages and 167 half-tone photographs, the author gives us a medley of sense and nonsense, good practical advice and suggestion, and wild theorizing, in English which is often quite as unorthodox as his science. The author evidently knows how to grow and care for trees, but he has not succeeded very well in telling us how he does it.

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INDUSTRIAL EDUCATION IN GERMANY.

MR. ERNST C. MEYER, U. S. Deputy Consul at Chemnitz, writes as follows to the Department of Commerce and Labor in regard to the relative part taken by private initiative and state aid in industrial education in Germany:

It was quite uniformly true that in the establishment of industrial schools private initiative took the lead. The state generally held back until the private schools had proved their usefulness. Then followed a state subsidy and a general supervisory power, and finally most of the industrial schools of higher rank passed over entirely into the hands of the state. The German deserves great credit for his enterprise and discerning powers in the field of industrial education. Many important trade and commercial schools of to-day were, at the time of their establishment by private individuals, attacked as wild fantasies. Not infrequently state aid was refused, and the individual was compelled to make the best of his own educational views until time vindicated his course. It is not too much to say that to private enterprise probably belongs the greatest credit in the development of Germany's unrivaled system of industrial schools. It was the chambers of commerce, the commercial organizations, the special trade organizations, the guilds, public-spirited benefactors, and men of wide educational discerning powers that contributed most in the construction of the splendid system of industrial schools.

Nor can this reasonably be interpreted as a criticism against the attitude assumed by the state. Records show that this attitude from the first, though not aggressive, was not hostile or condemning, but highly favorable to the establishment of industrial schools. It was probably great wisdom on the part of the state to avoid criticism at a time when criticism against industrial schools was particularly severe, to hold back and let private enterprise prove the value and efficiency of the schools before extending its own powerful aid and protection. To-day every government in the Empire is intensely interested in the welfare of the industrial schools. The time of experimentation as to their value is past. It is now a question of how most economically, most efficiently, and most rapidly to further develop these schools. Though private initiative in the early days broke the way, the state is to-day not delinquent in following out the advantages of early private experience.

The various governments exercise a powerful influence over the organization and work of the industrial schools and the dispensation of their subsidies. The allowance of a subsidy is generally conditioned upon the meeting of certain requirements in organization, entrance requirements, curriculum and grade of work. Schools which conform to the stipulated requirements enjoy financial aid, while others are assured of like aid as soon as the demands of the state are met. By this means it has been possible to introduce great uni-

formity into the numerous private institutions. The adopted standards are maintained and enforced by the state through an efficient system of inspection. Lagging institutions are threatened with the withdrawal of their subsidies, while efficient work receives recommendation. The public is kept informed of the entrance requirements, work, aims and discipline of the schools through the systematic publication of complete catalogues. Every industrial school, from the lowest trade school to the technical high schools, annually issues its courses of study, entrance requirements, tuition fees, final examination regulations, disciplinary codes, and all other matter of interest and importance to those who contemplate sending their sons or daughters to a trade school. Where a strict discipline is maintained, and no academic freedom permitted, as in all the lower trade schools, the catalogues invariably contain all the school statutes regulating the conduct of students in attendance. Special notice is given to parents that by sending their son to the school they imply an agreement to abide by the disciplinary code of the institution which, while not oversevere, is generally quite rigorous and keeps the young student within strict bounds of life.

THE JOHNSTON SCHOLARSHIPS OF THE JOHNS HOPKINS UNIVERSITY.

These scholarships, of which there are three, known as the Henry E. Johnston, the James Buchanan Johnston and the Henry E. Johnston, Jr., scholarships, were founded by Mrs. Harriet Lane Johnston, of Washington, formerly of Baltimore, in memory of her husband and her two sons. They are awarded annually by the trustees on the recommendation of the academic council. The stipend of each scholarship is the income of thirty thousand dollars. They are offered primarily to young men who have given evidence of the power of independent research. The holders will be expected to devote themselves to study and to research in their chosen subjects, though they may be required to do some teaching. Candidates for the scholarships must make application in writing, to the president of the Johns Hopkins University before the first of May. The application must be accompanied by such evidence of the candidate's fitness as he may be able to present. The president will refer the papers to the academic council, by whom the nomination will be made to the board of trustees, at their meeting in June. Holders of the scholarships may not engage in teaching elsewhere. The scholars will be appointed for one year, but if their work should prove satisfactory, they will generally be reappointed. Applications for the present year will be received up to January, 1905.

THE NEW YORK HISTORICAL SOCIETY.

On November 2 the president of the New York Historical Society announced the gift of about $200,000 towards the erection of the new building of the society, on ground already owned by them at Seventy-sixth and Seventy-seventh Streets and Central Park, West, New York. The foundations for the central portions of the new building are already constructed, costing some $70,000, and with the money in the treasury, $92,000, available for the new building, work has now been begun to erect a thoroughly modern building for the housing of the treasures of this society. The donor desired his name to be withheld, but the papers announce that it is Mr. Henry Dexter, who was one of the founders of the Metropolitan Museum, and his gift, $150,000 in cash and about $50,000 worth of granite, is in memory of his son, Orrando Dexter, who was killed in the Adirondacks. The society is one hundred years old on November 20, and this gift places it in a position where it can progress in its work in a more satisfactory manner than before. Few people know that this society possesses one of the finest art galleries in America, and a collection of Egyptian antiquities which Miss Amelia B. Edwards pronounced as the finest outside of Egypt and surpassing them in some lines. Of old New York history they are unsurpassed, but working quietly, their collection is overlooked except by the expert.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION C.

OWING to the large number of papers annually presented at the joint meeting of the American Chemical Society and Section C and the utter impossibility of reading them all with any hope of a proper appreciation of their contents, a radical change has been adopted in the arrangement of the program for this winter's meeting.

The time to be devoted to papers has been divided about equally between general meetings and meetings of subsections and the subsections have each been put in charge of a leader of wide reputation in the special department over which he presides. It is hoped thereby to arouse an increased interest in the hearers and particularly to stimulate discussion. Also it is hoped to increase the social intercourse and acquaintance of chemists who are working along the same lines of investigation.

At the same time the advantage of the general session is not to be lost sight of and the leaders of the subsection will recommend special papers of broad and general interest from among those presented to them to the sectional committee for a place on the general program. Details will be left to the subsections where they may be adequately discussed.

The leaders chosen for this year are: Dr. Arthur A. Noyes, physical and electro-chemistry; Dr. Jas. Lewis Howe, inorganic chemistry; Dr. James F. Norris, organic chemistry; Dr. Edward Hart, industrial chemistry; Dr. William P. Mason, sanitary, physiological and agricultural chemistry.

Abstracts of papers intended for the meeting may be mailed to me or may be sent direct to the leaders of the subsections. But one program is to be printed for this meeting, and to insure insertion all abstracts should be sent in time to reach me, directly or indirectly, before December 10.

CHARLES LATHROP PARSONS,
Secretary Section C.

DURHAM, N. H., November 9, 1904.

TRIMMED COPIES OF SCIENCE.

AT a recent meeting of the committee on the policy of the association, it was recommended 'That the publishers of SCIENCE be requested to announce prominently that cut copies will be sent to members who request it.' Trimmed copies of SCIENCE are now supplied to the news companies and to all subscribers who express a preference for them. Those who prefer trimmed copies should address a postal card to The Macmillan Company, 66 Fifth Avenue, New York City, and they will be thereafter sent.

Some subscribers to SCIENCE may wonder why all copies are not trimmed. It is not to save the cost, which is trifling, probably not more than the saving in postage. There are two reasons. One is that the copies can be bound to better advantage when they are untrimmed. The other appeals with unequal force to different people. It is largely a matter of tradition and association. The best journals and magazines have in the past been untrimmed, while the cheaper and more transient publications have been trimmed. An untrimmed journal looks to some of us as if it were ready for the binder and the library shelf, a trimmed copy as if it were half way to the waste paper basket. The larger margins look better, and the uneven edges represent the difference between objects that are hand-made and those that are machine-made. For the same reasons, SCIENCE is not wired, but sewn, though the cost is a little more. *Nature* has recently been trimmed and wired, the convenience being gained at a certain intangible loss of dignity and authority. The utilitarian will doubtless prevail over the esthetic in the end, and the argument from tradition and association will gradually lose its force. But SCIENCE is reluctant to break with its past and with a long literary tradition. Such conservatism may seem unreasonable, but it is at least harmless, so long as every one who wishes can receive trimmed copies.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR E. RAY LANKESTER, director of the Natural History Museum, London, has

been appointed Romanes lecturer at Oxford for the coming year.

Dr. Hermann Struve, director of the observatory and professor of astronomy at the University of Berlin, has been elected member of the Berlin Academy of Sciences.

Mr. H. H. Jeffcott has been appointed assistant in the metrological department of the British National Physical Laboratory.

Lord Kelvin distributed the prizes to the prizemen of St. George's Hospital Medical School on October 28.

A Japanese imperial medical commission has been making a tour of the health departments of the principal cities of this country and Europe. The commission consists of Dr. Takamine, professor of chemistry in the Imperial University at Tokio; Professor Tanva, of the department of pharmacy, and Dr. Sato, chief surgeon at the university.

Dr. W. A. Kellerman, head professor of botany in the Ohio State University, will spend January, February and March in Guatemala, studying and collecting the parasitic species of fungi of the native and cultivated plants of that country.

Captain Scott, R. N., and the officers of the *Discovery* Antarctic expedition were present at the opening of the Antarctic Exhibition of water colors, photographs and other articles of interest used in the South Polar regions during their recent expedition, which took place at the Bruton Galleries on November 4. Sir Clements Markham, president of the Royal Geographical Society, opened the exhibition.

Major Powell Cotton is about to start on an eighteen months' African expedition to explore the country lying between the Nile and the Zambesi.

Sir John Murray gave this week at Harvard University two lectures on 'Problems in Oceanography.'

On November 16 Dr. J. H. Woods, gave the first of three public lectures arranged by the Harvard Anthropological Society, speaking on 'Ghost Worship and Buddhism in India.' The other lectures in the series will be as follows: on December 2, 'The Characteristics of Primitive Culture,' Dr. Franz Boas, of Columbia University; on December 7, 'The Maya Hieroglyphs of Central America,' Mr. C. P. Bowditch, '63.

Dr. George T. Moore, director of the Laboratory of Plant Physiology of the U. S. Department of Agriculture, addressed the American Philosophical Society, at Philadelphia, on October 21, on 'A new method for the purification of water supplies.'

Dr. D. W. Johnson, of the Massachusetts Institute of Technology, has just completed a report on the 'Relation of the underground waters to the law.' It will be published in the reports of the eastern section of the Division of Hydrology of the United States Geological Survey.

The United States Geological Survey has just completed an arrangement with Dr. T. L. Watson, the recently appointed state geologist of Virginia, for cooperation in the investigation of the artesian waters of that state. These investigations will be carried on during the winter and following summer by Mr. M. L. Fuller, of the United States Survey, in conjunction with Dr. Watson, of the State Survey, and a joint report will be prepared early in the fall of 1905.

In addition to the commemoration of the two hundredth anniversary of the death of John Locke at the Johns Hopkins University, to which we have already called attention, the event was commemorated at the George Washington University, on November 12, under the auspices of the Society for Philosophical Inquiry. The program was as follows:

'Locke on Government': President Needham, of the George Washington University.

'Locke's Influence on Modern Psychology': The Rev. Dr. E. A. Pace, of the Catholic University of America.

Locke's Metaphysics 'of Causality and Space': Dr. Wm. T. Harris, U. S. Commissioner of Education.

'Locke's Personality': Hon. Frank Warren Hackett.

'Locke as a Physician': Dr. William Osler, of Johns Hopkins University.

Samuel W. Woodhouse, M.D., died in Philadelphia, Pa., on October 23, in his eighty-fourth year. He made explorations

in New Mexico and Arizona in the early fifties. Woodhouse's Jay (*Aphelocoma woodhouseii*) was named after him more than forty years ago by Professor Baird.

MR. GEORGE HENRY WITH, of Hertford, England, known for his scientific work, and especially for his specula for reflecting telescopes, has died at the age of seventy-seven years.

DR. HUGO HUPPERT, professor of physiological chemistry at Prague, died on October 19, at the age of sixty-three years.

THE Carnegie Museum has acquired by purchase for its library the collection of books and pamphlets on vertebrate paleontology made by the late Professor J. B. Hatcher, and the collection of writings upon invertebrate paleontology belonging to the estate of the late Professor C. E. Beecher, of Yale University. The acquisition of these two important working libraries, together with the large purchase of books on paleontology made by the museum in recent years creates in Pittsburg the nucleus of an exceedingly useful collection of works on the sciences to which Professor Hatcher and Beecher devoted themselves.

THE Messrs. Nicola Brothers, of Pittsburg, have presented to the Carnegie Museum a magnificent tusk of a mastodon found on their property at Sharon, Pa. Director W. J. Holland, of the museum, says it is one of the most beautifully preserved and perfect pieces of fossil ivory ever found in America, preserving its whiteness and grain in a splendid manner.

THE University of Chicago has been awarded Grand Prizes at the St. Louis Exposition as follows: (1) on the general exhibit; (2) on the work of the university press; (3) on the work of the Yerkes Observatory; and (4) on Professor A. A. Michelson's physics instruments.

Nature states that the Naples Academy of Physical and Mathematical Sciences offers prizes of 500 francs to the authors of the best papers in Latin, French or Italian on the two following subjects: the processes of formation of urea in the animal organism, and the evolution of the ovaric ovum in the Selacii. The essays are to be sent in anonymously, bearing a motto, on or before June 30, 1905. The Padua Society of Encouragement offers, to Italian subjects only, two prizes of 5,000 francs for an essay on the present state of the problem of electric traction on railways, and for a new method of diagnosing the disease of pellagra previous to its development. This competition closes on June 30, 1906.

THE London *Times* states that the steamer *Veronique*, of 3,264 tons, purchased by Lord Fitzwilliam, has sailed from Southampton on an exploring expedition in the Pacific *via* the Straits of Magellan. Lord Fitzwilliam and party embarked in the steamer, which is under the command of Captain E. Morrison, with a crew of 58 hands. It is said that the ship's destination is the Solomon Islands, where coal mines are reported to have been discovered.

THE American Association of Agricultural Colleges and Experiment Stations, met at Des Moines, Ia., last week. Officers were elected as follows: *President*, E. B. Voorhees, director of the New Jersey Experiment Station; *first vice-president*, G. C. Hardy, president of the Mississippi Agricultural College; *secretary and treasurer*, J. Hills, Vermont.

THE annual general meeting of the British Astronomical Association was held on the evening of October 26, Mr. S. A. Saunder, the outgoing president, in the chair. The election of the following as officers and members of the council for the session 1904–5 was announced: *President*, Mr. A. C. D. Crommelin; *vice-presidents*, Mr. E. W. Maunder, Mr. S. A. Saunder, Mr. G. M. Seabroke and Mr. C. T. Whitmell; *treasurer*, Mr. W. H. Maw; *secretaries*, Mr. J. G. Petrie and Mr. J. A. Hardcastle; *librarian*, Mr. F. W. Levander; *other members of the council*, Mr. C. L. Brook, Mr. A. Cottam, Mr. Tyson Crawford, Mr. H. Ellis, Mr. W. Heath, Mrs. E. W. Maunder, Mr. G. J. Newbegin, Mrs. Isaac Roberts, Dr. D. Smart and Mr. C. Thwaites.

UNIVERSITY AND EDUCATIONAL NEWS.

PARK COLLEGE, near Kansas City, has received an additional endowment of $100,000,

of which $25,000 has been given by Dr. D. K. Pearson.

At a recent meeting of the trustees of Columbia University gifts aggregating $46,850 were announced by the trustees. Among these was the sum of $15,000 from Gen. Horace W. Carpentier, of the class of 1848, to be added to the fund for the endowment of the chair of pediatrics, established at the College of Physicians and Surgeons by General Carpentier. Two other gifts were of $10,000 from the family of the late Dr. Guy B. Miller, M.S., '98, for the Medical School, and of $20,000 from an anonymous donor for a large plaster model of the university buildings and grounds for permanent exhibition.

An anonymous donor has sent a £1,000 Bank of England note to the treasurer of University College, Bristol.

Mr. Francis Galton, F.R.S., has founded in London University a fellowship for the promotion of the study of 'National Eugenics,' 'the study of the agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally.'

A new technical institute was opened at Danzig by the German Emperor on October 6. It has been built by the state at a cost of over $1,700,000 on land presented by the city of Danzig. It will have six faculties—architecture, building engineering and machine engineering, chemistry, general science and shipbuilding.

The statute for exempting from Greek candidates for the honors schools of natural science and mathematics, at Oxford, which is based upon the resolutions passed by congregation, on February 9, when the voting was 164 to 162, will be promulgated on November 29.

Edward H. Kraus, B.S. (Syracuse, '96), Ph.D. (Munich, 01), has been appointed assistant professor of mineralogy in the University of Michigan in the vacancy caused by the death of Professor W. H. Pettee.

Mr. E. D. Grant, who for some time past has been instructor in the department of mathematics and physics of the Michigan College of Mines, has recently been made assistant professor in the same department.

Dr. Andrew Sledd, A.M. (Harvard), Ph.D. (Yale), has been called to the presidency of the University of Florida, Lake City, Florida (formerly the State Agricultural College). The following appointments are also announced: Edward R. Flint, Ph.D. (Göttingen), M.D. (Harvard), professor of chemistry; M. T. Hochstrasser, M.E. (Georgia School of Technology), professor of mechanical engineering and drawing; F. M. Rolfs, B.S. (Iowa State College), M.S. (Colorado Agricultural College), professor of botany and horticulture; Karl Schmidt, Ph.D. (Marburg), professor of mathematics and astronomy; E. H. Sellards, A.M. (Kansas State University), Ph.D. (Yale), professor of entomology, geology and zoology. Two hundred and five students are enrolled, a substantial increase over former years. A new brick dormitory, 40 x 100 feet, replacing Foster Hall, burned in December, 1903, was opened for occupancy on November first. An effort is being made to develop the several departments on a university basis.

Mr. E. D. Sanderson, recently state entomologist of Texas and professor of entomology of Texas Agricultural and Mechanical College has resigned, and has assumed work at Durham, N. H., as professor of zoology at the New Hampshire College and entomologist of the Experiment Station.

Professor Bertram C. A. Windle, F.R.S., dean of the medical faculty and professor of anatomy in Birmingham University, has been appointed president of Queen's College, Cork, in succession to Sir Rowland Blennerhasset.

Mr. Alfred Young, lecturer in mathematics in Selwyn Hostel, Cambridge, has been elected to a fellowship of mathematics in Clare College.

Professor Primrose McConnell has been appointed lecturer in the Winter School of Agriculture, under the Essex Education Committee, in succession to Mr. W. Angus, appointed to the professorship of agriculture at Adelaide.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 25, 1904.

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ANIMAL MORPHOLOGY IN ITS RELATION TO OTHER SCIENCES.

IN the system of classification adopted by the organizers of this congress the science of animal morphology is apparently to be defined so as to exclude comparative anatomy. I take it, consequently, that it is intended to include only the broader problems connected with the form of animals—such as the phylogenetic evolution of form, the embryological development of form and the restoration of the mutilated form—in general, the form-producing and form-maintaining factors.

Expressed in this way the relations of animal morphology become more evident; and clearly the first and most intimate of these relations is with the morphology of plants. The separation of animal morphology from plant morphology in the department of biology, while according with a division of the subject found to-day in our universities, is, I think, not an ideal condition. For the form-producing and the form-maintaining factors are, at bottom, the same in all organisms. The problem of what factors have worked to determine whether a fish or a man shall have such and such a form is identical with that of the determination of the form of a fern or an oak. Little by little the morphologists that deal with the broader aspects of their science are being forced to face the absurdity of its division on the basis of the material studied. In cytology it is found that the maturation of the germ-cells, the fertilization of the egg and cell-divisions, are identical processes in the two 'king-

doms.' To admit a plant cytology and an animal cytology is only less absurd than to admit a mammalian cytology, an avian cytology and a reptilian cytology.

What is true of cytology is true of the other branches of morphology such as embryology in its broadest sense, the phenomena of regeneration and regulation in organisms, and especially the evolutionary history of specific forms. While in taxonomy we must continue to have botanists and zoologists, as we shall continue to have ornithologists, entomologists, etc., yet outside of the purely descriptive subsciences I would the gulf between botanists and zoologists were annihilated and that we had biologists separated rather in regard to *subjects* and university chairs, journals and societies devoted to evolution, cytology, ontogenetic processes and form regulation without regard to the systematic position of the material studied. Then we might hope to advance a subject instead of mulling over endless descriptive details.

We have next to consider the relations of morphology to form evolution or phylogeny. Before we can consider how a new form arises we must clear the field by seeking some element of form. The mass of material in the organic, like that in the inorganic, world early led to an attempt at the classification of these materials in both biology and chemistry. In chemistry a certain number of kinds of materials have in course of time been catalogued and are called substances, each of which has its particular *molecular* composition. In biology likewise many thousand kinds of organisms have been catalogued, and these are called species, each made up of particular sorts of *individuals*. Chemistry has gone a step further in its analysis of inorganic matter and recognized that the different molecules are made up of diverse combinations of a relatively small number of units called atoms. To-day biology has to recognize that its individuals are likewise diverse combinations of units—relatively very numerous—which, following de Vries, we call unit characters, or we may use the simpler name of 'characteristics.' Characteristics are thus to individuals what atoms are to molecules. As the qualities and behavior of molecules are determined by their constituent atoms, so the essence of the individuals of any species is determined by its constituent characteristics. And as we may construct new substances at will by making new combinations of atoms, so we may produce new species at will by making new combinations of characteristics. The making of new combinations in molecules or species is a useful work, but it is not evolution. Evolution in the inorganic or the organic world is first achieved when we can make new atoms or new characteristics, as the case may be.

This conception of species, which has arisen during the present decade, has its germ in the work of Mendel, and in consequence of the stimulating researches of de Vries, Correns, Tschermak, Bateson and others has developed into a stately doctrine, a doctrine which bids fair to revolutionize biology as the atomic theory did chemistry. It adds at once a new dignity and interest to morphology as well as to the description of species or taxonomy. In describing the form of an animal we are enumerating its qualities. Many of these are directly the unit characters of the species; others are composite and may be analyzed, by appropriate methods of breeding, into the elemental characteristics.

I may illustrate this by reference to domesticated poultry, to which I am now paying some attention. It is impossible to enumerate all of the characteristics of poultry, but the following are some of the most striking:

Size: Large and dwarf, which are ex-

emplified in the Asiatic breeds and the bantams.

Colors: Black; buff or red; white; brown (in the female) the male being often bronze, green, black, yellow and white; barred (as in the Plymouth Rock) and spangled (having center of feather of different color from periphery).

Comb: Single, pea, rose (flat, covered with tubercles, like a file); replaced by crest.

Legs: Feathered, featherless; black, blue, yellow, horn color.

Body shape: Short and chunky; tall and slender.

Now the various varieties of fowl are made up of various combinations of these characters. Thus we may have Plymouth Rocks which instead of having bars are pure white, or all buff; or the single comb may be replaced by a rose comb (when they are called Wyandottes), the usually clear legs may be feathered, and, finally, they may be 'bantamized.'

Any desired characteristic in the whole catalogue of poultry characteristics might be engrafted upon an original. Plymouth Rock stock. We might put on it the crest of the Polish fowl or the twisted feathers of the frizzle, or the loose barbs of the silky, or the taillessness of the rumpless or the long tail feathers of the Japanese long-tailed fowl. All this is of course possible because of the cross fertility of the races having these different characteristics. By similar procedure we might make a white, blue-eyed, deaf, long-haired, tailless, seven-toed cat; engraft the horns of the Dorset sheep upon the hornless Southdown; add the fecundity of the two-nippled horned Dorset to the multinippled condition of Dr. Alexander Graham Bell's flock. We might expect, after some experience, to do this with the same certainty that we can get calcium chloride and carbonic acid out of a mixture of hydrochloric acid and marble.

The bearing of this illustration, I repeat, is to show us that characteristics of species are entities not a little of whose interest lies in the question of their origin in each case. When we know how such characteristics arise, then we may call them forth at will and so determine the evolution of organic form. For the present it is sufficient that by the acquisition of new characteristics new species have arisen from preceding ones.

This assertion is justified by the examination of any extensive synopsis of species. Take, for example, de Bormans's synopsis of Forficulidæ in 'Das Tierreich.' Take any synoptic key at random. *Apterygida japonica* has two large tubercles at the end of the abdomen. *Apterygida allipes* has four small ones. *Anisolabis xenia* differs from *A. littorea* by slightly smaller size and especially by having two teeth in the forceps in the male or three in the female instead of none at all. I do not mean to assert that species have arisen *only* by an addition or subtraction of characteristics, but this is a common method. Very often we find one characteristic being replaced by another. Thus in Lepidoptera one species may differ from another in the replacement of red by yellow; or one earthworm will differ from another by having the sexual openings in different segments. We have no reason for thinking that these characteristics are not integral entities as much as those distinguishing domestic races. The modern morphologist, therefore, with the significance of characteristics in mind must appreciate that in enumerating these characteristics he is enumerating the steps of evolution.

The relations of morphology to embryology are so intimate that the latter is commonly reckoned a subdivision of the former. Certainly the interpretation of the

adult form depends on a knowledge of its development. 'In terms of the ancient riddle,' says Bateson (*Nature*, Vol. 70, p. 412) in his recent address as president of the section of zoology in the British Association, 'In terms of the ancient riddle we must reply that the owl's egg existed before the owl, and if we hesitate about the owl we may be sure about the bantam.' The characteristics of the adult form are implicit in the fertilized egg and are determined by the Anlagen of the characteristics wrapped up in that egg. We know now that upon the symmetry of the egg and of the successive cleavages often, if not typically, the symmetry of the adult form depends, and that upon the lack of symmetry of cleavage in Gastropods their lack of symmetry is probably to be referred. In the successive cleavages definite organ-tracts are marked off and still later the epidermal organs, such as hair, feathers and scales—the bearers of the more evident heredity characteristics—are laid down in regular lines radiating often from single points or groups of cells, thus simplifying the problem of inheritance of peculiarities of plumage or coat color by referring them back to transmission through particular cells or cell groups. It has thus been possible to show that all the numerous dorsal appendages of the nudibranch mollusc *Eolis* are derived from material split off in a regular manner and at regular intervals from a group of cells lying in the tail end of the developing animal. Thus the interpretation of the mechanism of transmission of qualities is first gained from a study of embryology.

A second way in which embryology has been regarded as indispensable to morphology is in the light it has thrown on homology. By homology—the will-o'-the-wisp of morphology—is meant such a similarity of unlike things in different species as would justify their receiving the same name. And one of the strongest grounds of a homology is similarity of origin regardless of function or even ultimate anatomical connections. The search for homologies has led to the idealization of the 'type,' and this more than anything else has blinded morphologists to the facts of variation and evolution. When, however, twenty-two vertebræ in place of twenty-one can nonplus the seeker after homology, its ethereal nature is sufficiently indicated. Homology may, indeed, exist between normal types, but the abnormal or pathological is often beyond homology and yet just the abnormal is, paradoxical as it may sound, the important for evolution.

As we study an organism's form we see that it is not made up merely of a great number of characteristics, but that these characteristics are, on the whole, such as enable the animal to thrive in its environment. We are struck by their 'adaptive' nature.

I am well aware that twenty years or so ago this side of morphology—the side, namely, of the accounting of an organism's form on the ground of use—was little cultivated. Morphology had for its aim the discovery of the interrelation of parts in the individual organism and the homology of parts in different individuals or species, and if it sought to go further it indulged only in speculative inferences as to the probable function of the parts. On the whole the student's attention was directed towards connections of organs and his natural inquiry as to use was stifled. Some one said that function varies while the form persists. This phrase became a dogma and function was considered a matter too trivial for consideration. Homology was the study for men of science; analogy was for the dilettanti. Morphologists should have been warned by cases like the whale whose teeth can not be homologized

with those of other mammals, and not have underrated the limitations of homology nor the importance of the study of adaptations. Only within the last few years have we come to recognize that every organ is more than a homologue: it is also a successful experiment with the environment.

The existence of that relation between form and environment which we call adaptation has been recognized for centuries, yet its full significance is still obscure. The prevailing theory (of Darwin) assumes that a change in environment precedes any change in form and that adaptation is, therefore, necessarily achieved by a change in the mean of the form to meet the changed demands of the new environment. This theory may, indeed, be said to be the natural outcome of the morphological doctrine of fundamental fixity of type. The type could be bent to meet new conditions, but could receive nothing new nor suffer loss of parts. I find that in the pre-Darwinian epoch Prichard suggested that the creator made the various species and placed them in habitats for which their structure fitted them. We see in this suggestion translated into modern terms the germ of a very different theory of adaptation from the prevailing one. I expressed this nearly two years ago about as follows: "The world contains numberless kinds of habitats or environmental complexes capable of supporting organisms. The number of kinds of organisms is very great; each lives in a habitat consonant with its structure." Each species is being widely dispersed while, at the same time, it is varying or mutating. By chance, some variants of the species get into an environment worse fitted for them; others into one better fitted. "Those that get into the worse environment can not compete with the species already present; those that get into a habitat that completely accords with their organization will probably thrive and may make room for themselves, even as the English sparrow has made room for itself in this country. This process may go on until the species is found only in the environment or environments suited to its organization. As Darwinism is called the survival of the fittest organisms, so this may be called the theory of segregation in the fittest environment."

The principle that animals are found in habitats for which their structure fits them, and not elsewhere, points to the close relation existing between morphology and geography. We find the animals of the seashore, such as sponges, Hydro- and Anthozoa, and tunicates, to be largely sessile, and in consequence, of the radiate type of structure. This sessile habit makes it possible for them to maintain their hold on the rocks from which the beating waves tend to tear them. Those which are not actually permanently attached have means enabling them to cling closely to the rocks; such are the echinoderms, the molluscs, many annelids and crustaceans. The animals of the surface of the sea, such as siphonophores, ctenophores, jelly fishes and larvæ, are without such clinging organs; they include species whose organization permits them only to float or swim at or near the surface. The deep sea could have been populated more readily, so far as proximity goes, from the surface organisms than from those of the shore line; but only the latter offered the structural features consonant with life at the sea bottom and so the deep sea became populated thence. In the swift-flowing rivers we find powerful swimmers or animals that can hold fast to the bed of the stream and in ponds we find those species which have some means of preserving their continuity in time of drought. In caves we get not any forms which happen to be washed into them, but only darkness, moisture- and contact-lovers. In deserts whole groups of

animals are absent, only those occurring with thickest skin—least apt to lose water by transpiration—such as certain snakes, lizards and hard-shelled beetles. In general, in studying the geographical distribution of animals in environments presenting extreme conditions we find that they clearly have been selected from groups presenting the most favorable characteristics. All of this indicates that, often at least, the already existing morphological conditions have determined the fitness of a species to cope with the environment—morphological characteristics have determined geographical and climatic distributions.

Morphology as the science of form is often contrasted with physiology, the science of function. Yet between the two is the closest possible relation, because an organ implies a function and every morphological characteristic has a corresponding physiological characteristic. As physiological characteristics are transmissible in the same way as morphological, we may think of any individual as being made up of such functional characteristics, just as a molecule is made up of atoms, and in the transfer from one race or species of a set of morphological characteristics we transfer likewise the corresponding set of physiological characteristics. Thus to return to poultry, we find the rate of growth, the age at maturity, the egg production, the brooding instinct and the resistance to disease to be characteristics of various races, and it is quite possible to combine such characteristics—in so far as they are not incompatible—in various ways. Thus we have poultry that mature early, lay many eggs and are not broody—of these the white Leghorn is a good example. Or, we may have poultry that grow large, mature late, lay throughout the winter and are very broody—such are the Cochins. This similarity in capacity for making combinations which we see between physiological and morphological characteristics proves their close kinship and the unscientific nature of the division which would relegate their study to distinct sciences.

What is true of domesticated races is true also of wild species. Biology has suffered from the circumstance that species have been studied almost exclusively from dead specimens. Attention is focussed on proportions in the dimensions of bones, on number of spines, on antennal joints, on shell markings and so on, and we seem to have overlooked entirely the fact that all these characters constitute only one face of the shield. The structural descriptions of the systematist give us a no more adequate idea of the characteristics of species than does the sight of this exposition on a Sunday when all wheels are stopped and only the form, beautiful and grand as it is, remains give us an adequate idea of it. And so in the study of species we can not understand the form characteristics without considering also the function characteristics. I may illustrate this by some studies which Miss Smallwood has been making at Cold Spring Harbor. She started with a species of Amphipoda—*Talorchestia longicornis*—that lives on the beach where it is rarely covered by the tide. After studying its form and behavior for several months she investigated a second species of the same family of Orchestidæ, *Orchestia palustris*, that lives on the salt marsh to the limit of the highest tides. After studying this for some weeks with respect to behavior correlated with structure she has begun on still a third species of the same family, *Alorchestes*, which is a typical aquatic organism. The instructive thing that comes out of her studies is that in just the same way as these species differ in structural characteristics they differ in functional characteristics and the two kinds of differences go hand in hand and they have to be studied together to be fully intelligible

In still another way are the dynamical and static characteristics bound together, for every form or part has not merely a form or function, but a development, and development is a dynamical process. A decade or two ago embryological development was regarded as a purely morphological subject, as a series of stages, and little attention was paid to the causes that produce the stages and the succession of organs. During the last decade, however, partly under the stimulus of physiologists who have entered the field of embryology, its dynamical problems have been studied also by morphologists. As a result of the researches of Loeb, Driesch, Herbst, E. B. Wilson, Morgan and many others we have come to recognize that the egg is organized —cytoplasm as well as nucleus—and that it exhibits varying degrees of organization in different cases. Sometimes it seems as though every part of the egg was totipotent, as in the medusæ; in other cases, the different parts of the cytoplasm seem told off to develop into particular and definite organs, as in some molluscs. We have learned, further, that at every stage new organs are called forth and their development directed by stimuli proceeding from already existing organs.

Moreover, it has been found that even adult structures are dependent upon external conditions for their form. It appears that peculiar functioning may alter the form of internal organs, as has been demonstrated in the case of a ship's trimmer and of a cobbler by Lane, and as a vast number of pathological cases testify, such as the alteration of the arrangement of plates in the spongy tissue in the head of the femur, and the functional hypertrophy of the other kidney after the loss of one. Morphologists have been forced to realize that form and structure can not be dealt with aside from function and behavior. Every part of the living body is a sensitive responding part whose sensitiveness determines structure. This is seen particularly well when the body is mutilated or a part removed; then begins the wonderful process of regeneration or regulation by which, under control (in the higher animals) of the nervous system, the lost parts are in many cases restored. In truth, the work of the morphologist has extended into the realm of the form-developing and form-maintaining factors and this is a physiological realm.

From these experiences I conclude that the morphologist who studies form characteristics only is too narrow. *Characteristics* in their twofold aspect of form and function should be the object of his investigations—their difference in allied species, their integrity, their behavior in breeding, their phylogenetic origin, their embryological development and their maintenance in the adult.

Morphology has relations with sciences quite outside of biology. I have already insisted that the problems of form and structure are also physiological problems, but in last analysis they are, I think, problems of physics and chemistry. For myself, I have no doubt that we shall some day be able to prove that each characteristic of an organism depends upon a specific substance in the germ cell, and we may hope by altering this substance experimentally to change the corresponding characteristic. Such a change is mutation and mutation in last analysis, as de Vries maintains, depends upon external conditions.

Apart from this it is certain that the physiological processes involved in the individual's characteristics are modifiable and, indeed, controlled by physical agents in the environment. Thus it has been possible to show that certain salts play special rôles in the development of particular organs or characteristics (Herbst). Loeb, indeed, has shown that regeneration of

hydroids does not occur in the absence of potassium. We know, likewise, that iron is necessary to the formation of the chromatin of the nucleus.

The physical conditions have likewise an influence in morphogenesis. The rate of development is controlled within limits by temperature. The number and position of stomata and of leaves by light and moisture; the number and form of plant hairs by moisture; the position of branches and leaves on a stem by gravity; the formation of a hydranth in a hydroid stock by light. So evident is this dependence of morphogenesis upon physical agents that two individuals of the same family develop alike only under the same conditions of environment.

There remain to be considered the relations of morphology to the queen of the sciences—to mathematics. Until recent years little relation has been recognized, and this I attribute to the fact that few naturalists have a type of mind that attracts them to mathematics. They have usually been led to their science through a love of nature—a passion that belongs rather to the poetic type of mind than to the severely precise mathematical. And so I find that, even to-day when the bearing of mathematics on morphological problems can not be overlooked, few morphologists take an interest in the subject of biometry by which the two sciences are connected.

The fact that few morphologists have little taste for mathematics can not stay the inevitable trend of the science toward greater precision of expression and toward mathematical analysis. Until recent years characteristics have been described only in the crude language of adjectives and adverbs—where greater precision is necessary quantitative expression is inevitable. So we have seen during the past ten years the rise of biometry and its application to many morphological problems. Biometry had its beginning in the suggestive investigation of Galton; its great development in the last ten years has been due, above all, to the tremendous activity of Karl Pearson and the workers he has gathered about him. By the aid of efficient methods of analysis we are able to state quantitatively not only the mean value of any measurable characteristic, but also the degree of its variability and the closeness of associated variability of two interdependent organs. Moreover, it is possible to study the nature of the variability exhibited by any characteristic in any homogeneous lot of individuals and to draw an inference from the nature of this variability—as exhibited in the variation polygon—concerning the condition of the characteristic in question in the given race. A person of experience can tell from a glance at the variation polygon whether the race is in a condition of equilibrium so far as this characteristic goes, or whether it is breaking up into several forms or is, perhaps, evolving into some other condition. The quantitative expression gives a means of measuring change of the mode from epoch to epoch which Weldon used in studying the crabs at Plymouth and which enabled him to demonstrate a progressive change in form. It gives also a means of measuring the alteration of an organ in different environments and so of estimating the effects of changed external conditions. Thus it has been shown that the modal number of ray flowers in the ox-eye daisy depends upon the conditions of nutrition in the soil; the chela of the male crab, *Eupagurus*, is relatively smaller in *deep* water; the mud snails, *Nassa*, of *brackish* water are depauperate.

Again, mathematical methods have given us a measure of the correlation between organs, so that the exact relation between human stature and the length of a long bone being known, the stature of extinct

races may be calculated from a collection of disinterred femurs. Pearson has been able to show that there is no correlation between shape or size of the head and intelligence, and to demonstrate the efficiency of vaccination and the non-inheritableness of cancer. The opinion that various bodily characteristics are bound together has been substantiated by studies in the correlation of all sorts of organs in plants and animals and the degree of this correlation measured. This index of correlation measures the degree of morphological kinship or of physiological interdependence. Symmetry gains a quantitative expression and it is interesting to find that originally non-symmetrical organs which have secondarily gained antimeric relations—as in animals that habitually lie on one side—gain a very high index of correlation. Thus I find in the scallops (*Pecten*) which are lamellibranchs that have come to lie on the right side the index of correlation between the dorso-ventral and antero-posterior diameters is 97 per cent., whereas the correlation between the breadths of the right and left valves is only 86 per cent. As heredity is only one phase of correlation, the inheritance of characteristics can, by the new methods, be exactly measured. It is demonstrated that there is such a thing as prepotency of one parent and that heredity is weakened by change of sex. It is shown that mental and physiological characteristics are inherited exactly like morphological characteristics; and that the relationship between the leaves of a branch or the zooids of a colony is like that between brothers of a family. We learn that all inheritance is not all of one kind. That certain characteristics, like stature and skin color, blend in the offspring; while others, like the coat color in mice, refuse to blend and may be inherited according to Mendel's law.

By mathematical analysis the selection of particular characteristics, or those of a particular degree of development, has been demonstrated and the exact effect of the selection process upon the frequency polygon has been made clear. Extreme variants are often annihilated, although in other cases the position of the mode is shifted. Finally, through quantitative studies the existence of local races has been clearly proved—the degree of their differentiation and its dependence on environmental conditions has been measured. It has been shown that a characteristic does not remain the same in all localities and under all conditions, but may become slightly altered. This fact speaks strongly for the contention that new species may in some cases have arisen by the summation of infinitesimal differences—that not all evolution is by mutation.

In concluding this address I am impressed by the fact that to-day any science ramifies in all directions toward every other. There can be no doubt that the most fruitful work in any science is to be done in the border line between it and some other science. There is another corollary to this close interweaving of the sciences and that is that the existing classifications have become antiquated. Our university departments, our societies and our journals still, for the most part, draw the old lines. Yet the true work of science has, I apprehend, overleaped the barriers of these classifications, and the best workers will in the immediate future be no longer botanists or zoologists, or chemists or mathematicians, but will be interested in particular subjects—in following some favorable lead into the unknown. The embryologist who is interested in processes, the cytologist who is interested in the fertilization of the egg will feel free to work on any material, whether plants or animals or crystals or colloidal mixtures—and by any methods that seem likely to be of aid

to him. And I hope to live to see the day when our now overgrown zoological and botanical societies shall languish while groups of men devoted to a common subject and investigating it with the most diverse material will meet together to discuss results of common interest. When a subject no longer demands vigorous investigation and the center of activity is shifted elsewhere I should like to see the old associations abandoned and new ones formed to advance the newly risen problems. Our large societies are a hindrance, I sometimes think, rather than a means of advancement to science. We want smaller meetings with more acute interest. And, finally, I can not but remark on the vastness of the preliminary training which the present ramifications of every science make necessary. Research in the fields between the old sciences has rewards for the investigator, but he who would reap those rewards must prepare himself through years devoted to gaining the mastery of many sciences.

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*THE PROBLEMS OF INTERNAL MEDICINE.**

To recognize, to prevent, to protect, to heal—these are, in the broadest sense, the tasks of internal medicine now as ever. But how different are the problems which occupy our attention to-day from those of the period commemorated by this congress. Let us for a moment glance back at the medicine of the close of the eighteenth and the beginning of the nineteenth centuries. For over two hundred years the blind and binding faith of the middle ages, the faith that had so long fettered the human mind, had been slowly giving way before the forces of reason and truth. Now and again with ever-increasing frequency, great and courageous minds had risen above the clouds of medical tradition and dogma, which had smothered the understanding and reason of mankind, as if, indeed, medicine were a part of the religious doctrine which ruled the world. For truly the medicine of the middle ages was largely a matter of faith, and as a matter of faith one in which reason beyond a certain point was heresy and sacrilege. Vesalius with genius and courage had begun to withdraw the veil from naked and iconoclastic truth. Harvey had made his great discovery. Glisson had demonstrated his theory of irritability. Mayow with his 'Spiritus nitro-æreus' had anticipated the discovery of oxygen. Leeuwenhoek and Malpighi and Hooke had opened to the human eye the realm of the infinitely small. Bacon and Descartes and Newton and Locke had introduced into the world a rational and natural philosophy. Locke, himself, indeed, a wise physician, had pointed clearly to the true path of medical progress. "Were it my business," says he, "to understand physick, would not the safer way be to consult nature herself in the history of diseases and their cures, than espouse the principles of the dogmatists, methodists or chymists."

But the clouds of medical tradition were slow to clear away. Gradually, however, the first 'lonely mountain peaks of mind' had been followed by an ever-increasing number of earnest and untrammeled students. In the seventeenth century the opportunity to give one's life freely to the search for truth had become more and more open to all. The mysticism and animism of Stahl which, in the early part of the eighteenth, hung over the medical world, was already breaking away. The study of the natural sciences was pursued more eagerly and generally than ever before.

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Reaumur and Black and Haller and Spallanzani and Hunter and Priestley and Lavoisier had lived. Morgagni, sweeping aside the dogmatism of the old schools, had demonstrated the local changes in many diseases and had opened the way for the objective pathological anatomy of Bichat. In the field of practical medicine such men as Sydenham and Morton and Torti and Lancisi practised and taught much which holds good to-day. Boerhaave had introduced clinical instruction. Cullen and Cheyne and Huxham and Pringle and Heberden and Van Swieten and De Haen were all in many ways true and faithful students; yet methods and doctrines that were often strangely fantastic still held general sway—such, for instance, as the Brunonian system. A perusal of the writings of Stoll, one of the wisest practitioners of his day, can not fail to impress one with the meagreness of the basis of anatomy and physiology, normal and pathological, on which medicine rested, the almost entire lack of diagnostic methods, the absence of a rational therapy—how much of the conjectural, how little of the scientifically exact there was in medicine.

Diagnosis, based largely upon gross clinical conceptions, was necessarily vague and uncertain.

Prophylaxis, in the absence of any certain knowledge of the causes and manner of origin of disease, was devoid of any sound basis.

Treatment was almost wholly empirical, and, where it was not empirical, it was frequently based upon some theoretical system so arbitrary and dogmatic that the unfortunate sufferer was too often stimulated or purged, fed or bled, as he fell into the hands of a Brown or a Broussais rather than according to the nature of his malady.

In the Dictionaire de l'Académie française for 1789, a year which marks the end of an era in the world at large, one finds the following definition: "Médecine. s. f. L'art qui enseigne les moyens de conserver la santé & de guérir les maladies (La médecine est un Art conjectural * * *)." Medicine, a conjectural art! Such was the estimate placed upon our profession by the French Academy a little over one hundred years ago.

But the seeds of a new life had been sown and the germination had already begun. Even as these words were written Lavoisier, too soon to fall a victim to the premature explosion of the forces of pent-up freedom, was in the midst of his great work. In 1796 came the introduction of vaccination by Jenner, and but a few years later Bichat, with his wonderful genius, took up the thread dropped by Morgagni and placed anatomy and physiology, normal and pathological, on a basis of accurate observation and experiment. Hand in hand with the introduction of exact methods of anatomical and physiological observation, Auenbrugger in 1761 had demonstrated in his 'Inventum Novum' a method of physical investigation which, for the first time, enabled the physician to determine changes in size, shape and consistency of the thoracic organs. At first unnoticed by the world, this important discovery was destined to gain a sudden general recognition in the early days of the nineteenth century. With the spread of knowledge of the gross pathological changes in disease which followed the inspiration of Bichat, the work of Auenbrugger, expounded by Corvisart, became a common possession of the medical world, and less than ten years later, Laënnec, by the introduction of mediate auscultation, opened possibilities for accurate physical diagnosis such as had not been dreamed of in the ages which had gone before.

With the great school of French observers which followed Laënnec, Andral, Chomel, Louis, Bouillaud and Trousseau,

with Skoda and Schönlein in Germany and Addison and Bright and Stokes in England, the exact association of clinical pictures with local anatomical changes made great advances. Typhus and typhoid fevers were distinguished; the relation between albuminuria and renal disease was demonstrated; the association of endocarditis with acute rheumatism was discovered; the corner-stone of our knowledge of cerebral localization was laid. Clinical diagnosis was becoming more than a conjectural art.

In the meantime physiology was making great strides. Majendie, Bell, Johannes Müller, Beaumont and finally Claude Bernard, and a host of their followers, were shedding light upon many obscure corners of our knowledge of the vital functions. In the hands of Müller the microscope began to open up new fields of study which were destined in a few years, through the cultivation of the genius of a Virchow and a Max Schultze, to bear a noble harvest. The 'great reform in medicine' which followed the introduction of the cellular pathology laid solid foundations for much which is most vital in our anatomical and physiological and pathological knowledge of to-day, and the correlation of these observations with the results of accurately recorded clinical studies, the application of the microscope to the study of the urine, the sputa, the blood, to pathological neoplasms, to exudates and transudates, soon brought new material for the rising edifice of a rational, exact diagnosis. The sphygmograph, the thermometer, the ophthalmoscope, the laryngoscope, the binaural stethoscope, the stomach tube, the various means for studying the blood pressure, all have brought their aid, while but yesterday the discovery of Roentgen has given us new and unhoped for diagnostic assistance.

At the same time, physiological chemistry which, with the work of Berzelius on the urine, had taken its place by the side of the more purely physical methods of investigation, has year by year given us greater diagnostic assistance in the analysis of the different secretions and excretions of the body and in the explanation of the various metabolic processes of the economy.

The development in the hands of Duchenne and Erb and Remak of electrical diagnosis, together with the great advances in physiology and pathology of the nervous system, have afforded explanation for much that was previously incomprehensible and have given us powers of diagnosis which, a few generations ago, would have seemed almost magical.

Finally Pasteur and Koch, with the introduction of bacteriological investigation, opened the way to the discovery of the causal agents of a large group of infectious diseases. These discoveries, followed rapidly by the evolution of methods allowing of the clinical demonstration of many pathogenic micro-organisms, afforded an early, exact and positive diagnosis, on the one hand, in conditions where previously the disease was recognizable only at a stage in which it had made inroads into the system so great as to be often beyond relief, as in tuberculosis, and, on the other, in maladies the existence of which, without these methods, was to be definitely determined only after the onset of an epidemic, as in cholera, plague and influenza. When one thinks of what the last quarter of a century has taught us with regard to tuberculosis, anthrax, tetanus, diphtheria, typhoid fever, cholera, plague, dysentery, influenza, not to speak of the great group of wound infections, we may begin to realize what bacteriological methods have done for diagnosis —how many diseases have been cleared up —how many symptoms have been explained.

In like manner Laveran with the discovery of the parasite of malarial fever,

did much to bring certainty and precision into a field in which many had gone astray, while opening the way for the important observations of Theobald Smith and all the knowledge which we have gained in recent years with regard to the hæmatozoa of man and animals.

As a direct result of the introduction of bacteriological methods, the study of the manner of action of infectious agents and their toxic products upon the animal organism, as well as of the powers of resistance of the economy against infection, has given us, with the discovery of specific agglutinines and precipitines, diagnostic methods of the greatest value, not only for the recognition of various infectious processes, but for the identification of specific sera, affording in particular a test for human blood destined, probably, to prove, when properly applied and interpreted, of great medico-legal value.

This is, indeed, a gain over our knowledge of one hundred years ago. In how many fields has the conjectural given way to the exact! At the end of the eighteenth century the diagnostic effort of the physician, unaided by instruments of precision or even by the simplest physical methods of auscultation and percussion, was directed toward the detection of gross anatomical changes. To-day with our increased knowledge of anatomical, physiological and pathological processes, with our growing insight into the chemical and physical features of vital activity, our duty no longer ends in the recognition of physical changes in organs, in the determination of the presence of a specific lesion or infection; it is, further, our task to search for the earliest evidence of disturbance of function which may later lead to grosser, more evident change, to separate the physiological from the pathological, to estimate, as far as may be, the power of resistance of the different organs and tissues and fluids of the body to insults of varying nature, to determine the functional capacity of a given organ—its sufficiency or insufficiency. In addition to increasing opportunities in the field of pathological anatomy we find ourselves drawn further into the study of pathological physiology—and knowledge in the field of pathological physiology leads of necessity to power in functional diagnosis.

It must be acknowledged that with regard to many organs the determination of the limits of functional power and the estimation of the degree of impairment in disease, are matters most difficult to appreciate, yet with improved methods and persistent research progress is being made.

We are, after all, but beginning to realize a few of the possibilities before us, but even this is a step in advance which holds out no little promise for the future and offers new and tempting opportunities for study and investigation.

At the end of the eighteenth century but three important, rationally conceived measures of prophylaxis had been practised—the dietetic measures of protection from scurvy, the older inoculation and Jenner's great contribution of vaccination against small-pox. It was not, indeed, until the development of bacteriology that prophylaxis took its place as a scientifically exact branch of medicine. The recognition of the specific cause of many infectious diseases, the knowledge of the life history of the pathogenic micro-organisms, the discovery of the portals through which they gain entrance to the animal economy, and the conditions under which infection occurs, have brought to us material powers to prevent and protect. The first great result of this new knowledge was the development of antiseptic surgery and all that it represents. But apart from this we have but to remember what has been gained by a scientifically evolved prophylaxis against

tuberculosis and typhoid fever—to reflect upon how far cholera and plague have lost their terrors—to contemplate the brilliant results of the discovery by Ross and the Italian school of the life history of the malarial parasites as manifested in the anti-malarial campaigns carried on in various regions by Koch, and in Italy by the Society for the Study of Malaria, a noble institution of which our Latin brothers may well be proud, and lastly, to look upon the beneficent and far-reaching influence of the recent work of Reed and Lazear and Carroll and Agramonte with regard to yellow fever, to realize what bacteriological and parasitological studies are doing for preventive medicine.

But beyond this external prophylaxis, the studies of the problems of immunity beginning with Pasteur's inoculations against anthrax in 1881, have given us, so to speak, an internal prophylaxis, a functional prophylaxis if one will, in the possibility of producing a greater or less degree of individual immunity, such, for instance, as is now possible in diphtheria, cholera, plague, typhoid fever and dysentery.

The enforcement of scientifically planned and accurately deduced prophylactic measures has become to-day one of the main duties of the practitioner of medicine. It is as much the task of the physician nowadays to guard over the disposal of the sputa of his tuberculosis patient, of the excreta of the sufferer from typhoid fever or cholera or dysentery, as it is to attend to the immediate wants of the invalid. How rapidly has the exact replaced the conjectural in this branch of medicine!

But while diagnosis and prophylaxis were being removed from the domain of conjecture to the field of exact observation and reason and research, while the possibilities of surgery were rapidly widening through the discovery of anæsthesia and the introduction of antiseptic methods, medical treatment, until the last two decades, still remained largely empirical. The development of exact clinical methods of observation and the statistical tabulation of experience for which we are especially indebted to Laënnec and Louis and their followers, gradually brought about, to be sure, many advances, while a large number of useful therapeutic agents introduced by the newly developed science of pharmacology, and exactly tested by improved methods of physiological study added greatly to the armamentarium of the physician for the relief of symptoms. The power to combat disease specifically, however, remained much as it was at the beginning of the century. Mercury in syphilis, quinine in malarial fever, were the only specifics known to the medical world—and the action of these was unexplained.

The introduction by George Murray, less than fifteen years ago, of the treatment of myxœdema and allied conditions by extracts of the thyroid gland, was a direct application of the results of physiological observation to the treatment of disease. If this gave rise to hopes of the possibility of obtaining like results from roughly obtained extracts of other ductless glands, which have hardly been fulfilled, yet this discovery was the first step toward the rational scientific therapy to which we are beginning to look forward to-day.

But a moment ago I spoke of the importance of the influence of the discovery of the causal agents of the infectious diseases upon the development of exact diagnostic and prophylactic methods. Great and impressive as these have been, yet the studies which have followed as to the manner in which these agents act upon the human organism, and of the powers of resistance which the body exerts against them, the investigation of the problems of immunity, have opened out a far wider field. The early studies of Metschnikoff and Buchner

and Nuttall were followed with rapidity by the epoch-making work of Behring and Kitasato and Roux with regard to tetanus and diphtheria. The diphtheria and tetanus antitoxines were not chance discoveries of empirically determined virtue, but true specific, therapeutic agents, the results of experiment scientifically planned and carefully prosecuted. Widespread investigations of the various phases of immunity, bacterial and cytotoxic, have given us in a few short years a mass of physiological knowledge, the full import of which is scarcely yet to be comprehended. Few things in modern medicine are more impressive than a survey of the work of the last twelve years done under the inspiration of Ehrlich.

Beside the antitoxines of diphtheria and tetanus and the power of producing a greater or less degree of immunity, as has already been mentioned, by preventive inoculations against cholera, plague and typhoid fever, we have come to possess a bactericidal serum of a certain value in combating the actual disease, plague, while the favorable influence of Shiga's antidysenteric serum seems to be undoubted. There is much reason to hope that the recently promised anti-crotalus serum of Noguchi as well as the anti-cobra serum of Calmette may prove to be real boons to humanity. But it is not alone in the production of specific anti-sera, that the therapeutic value of the modern studies of immunity lies. There are signs which justify us in looking forward to the possible discovery of an explanation of the mode of action of substances long empirically used, knowledge the value of which may be readily appreciated.

When we consider these facts it is, indeed, easy to appreciate to what an extent the exact has driven the conjectural from this last field of medicine. A hundred years ago we were depleting and purging and sweating and bleeding according to theories often strangely lacking in foundation, the prevalence of which depended rather upon the individual force and vigor of the expounder than upon their intrinsic merit. To-day from the study of the pathological physiology of bacterial and cytotoxic intoxications, we are rapidly evolving scientific preventive and curative measures, while searching out the rationale and mode of action of our older therapeutic agents.

But a few days ago, I happened to open a copy of Littré* bearing, by a curious chance, the date of 1889, and read "Médecine. (mé-de-si-n') 1° Art qui a pour but la conservation de la santé et la guérison des maladies, et qui repose sur la science des maladies ou pathologie"—an essential modification of the definition of one hundred years before and indicative of the changes of a century.

To meet the manifold problems of to-day the training of the physician must, of necessity, be very different from what it was a hundred years ago. The strong reaction which set in in the earlier part of the nineteenth century against philosophical generalization in medicine, the insistence upon a strict objectivity, all the more emphatic because of the prevalence of anatomical methods of research, have held very general sway. Medicine, no longer resting upon a basis of philosophical speculation, stands upon the firmer foundation of the exact natural sciences. Almost from the beginning the student of to-day is taught methods, where a hundred years ago he was taught theories. The enormous expansion of the field which must be covered has led, naturally, not only to an ever-increasing specialism, but to the fact that the course of study which is regarded as properly fitting the physician for practise is reaching backward farther and farther into the earlier years of his school training.

* Dictionaire de la langue Française.

On the other hand, in this country at all events, there is heard a common cry that the academic medical training is extending on the other side into years which should be given to practise; that the expense and duration of a medical education so-called will soon be such as to shut out from the profession many a man who might be a useful physician and perhaps a valuable contributor to the world's knowledge. To remedy this it is advised that the prospective student of medicine should be led from the earliest stages of his training through the paths of exact research into the domain of the natural sciences to the greater or less exclusion of the classics—the old-time humanities, the study of which, useful as it may be from a standpoint of general mental training, is believed by many to be time wasted in the education of the student destined for a scientific career.

But there are not wanting voices which question the wisdom of the full extent of some modern tendencies. May the affectation of too strict an objectivity bred though it may be of a wholesome skepticism, the more general cultivation of the natural sciences to the exclusion of the humanities, the search for facts and facts alone, circumscribe the powers of synthetical reasoning without which the true meaning of many an important problem might pass unnoticed? May they, perhaps, tend to smother the development of minds capable of grasping large general problems? Do the tendencies of the times justify the epigrammatic observation of a recent French author: "Autrefois on généralisait avec peu de faits et beaucoup d'idées; maintenant on généralise avec beaucoup de faits et peu d'idées"?*

That the cultivation of a strict objectivity in research has materially impaired our powers of reason—that the exact methods which are largely responsible for the enormous advances of the last fifty years in all branches of medicine have bred a paucity of ideas, I am not inclined to believe, despite the seductive formula of our Gallic colleague. But that when, in the period of so-called secondary education, it is proposed to *substitute* the study of the natural sciences for a good training in the humanities, there is danger of drying up some of the sources from which this very scientific expansion has sprung, seems to me by no means impossible. The study of the classics, an acquaintance with the thoughts and the philosophies of past ages, gives to the student a certain breadth of conception, a stability of mind which is difficult to obtain in another way. A familiarity with Greek and Latin literature is an accomplishment which means much to the man who would devote himself to any branch of art or science or history. One may search long among the truly great names in medicine for one whose training has been devoid of this vital link between the far-reaching radicles of the past and what we are pleased to regard as the flowering branches of to-day. Greek and Latin are far from dead languages to the continental student. They are dead to us because they are taught us as dead. With methods of teaching in our secondary schools equal to those prevailing in England and the continent, 'twould be an easy matter, in a materially shorter period, to give our boys an infinitely broader education than they now receive. There should be much less complaint of time wasted, much less ground for suggesting the abandonment of the study of branches which are invaluable to any scholarly-minded man.

The assertion that the time spent in the study of the humanities results, in the end, in the encroachment of the academic training upon a period which should properly

* Eymin, 'Médecins et philosophes,' 8°, Lyon, 1903–4, No. IV.

be given to one's life work is, it seems to me, often based on an old idea—founded all too firmly, alas, on methods that yet prevail in many of our medical schools—that with his degree in medicine the student has finished a theoretical education, that he must now spend five or ten years in acquiring experience—at the expense, incidentally, of the public—before he can enter into his active life; that, therefore, unless some other branches of early instruction be sacrificed to courses leading more directly to medicine so that he may enter upon his strictly professional education at a period considerably earlier than is now the case, the physician of to-morrow will become self-supporting only at a period so late in life as to render a medical career impossible to other than those well supplied with the world's goods. With proper methods of instruction this is a wholly false idea. Under fitting regulation of our system of medical training, with due utilization of the advantages offered by hospitals for clinical observation, the experience necessary to render a man a safe and competent practitioner should be not only offered, but required for a license to practise; and even if the length of the strictly medical curriculum be extended one or two years beyond that which is at present customary, it will not be time lost. If one but look around him he will find, I fancy, that few men who have had such a training wait long before finding opportunities for the utilization of their accomplishments; the public, in most instances, soon recognizes the man of true experience.

But there is yet another side of the question which has hardly been sufficiently emphasized, a side of the question which must come strongly to one's mind when he considers the general education of many of the men who are entering even our better schools of medicine, a point of view which has been especially insisted upon by a recent French observer. A large part of the success and usefulness of the practitioner of medicine depends upon the influence which he exerts upon his patients—upon the confidence which he infuses—upon his power to explain, to persuade, to inspire. It can scarcely be denied that these powers are more easily wielded by the man of general culture and education than by one of uncouth manner and untrained speech however brilliant may be his accomplishments in the field of exact science. I can do no better than quote the words of Professor Lemoine: "C'est qu'en effet l'action morale qu'il peut exercer sur le malade, et qu'il exerce d'autant plus qu'il est supérieur par son intellectualité, est un des principaux éléments de guérison. On guérit par des paroles au moins autant que par des remèdes, mais encore faut-il savoir dire ces paroles et présenter une autorité morale suffisante pour qu'elles entraînent la conviction du malade et remplissent le rôle suggestif qu'on attend d'elles. Ne fut-ce que pour cette raison, je me rangerai parmi ceux qui demandent le maintien d'études claissiques très fortes comme préparation à celles de la médecine, car le meilleur moyen de rehausser le prestige du médecin c'est encore de l'élever le plus possible au dessus de ses contemporains."*

* Indeed the moral influence which he [the physician] is capable of exercising upon the patient and which he exercises to an ever increasing degree with his intellectual superiority, is one of the most important of therapeutic agents. One heals by words at least as much as by drugs, but one must know how to *say* these words and to exercise a sufficient moral authority, that they may bring conviction to the patient and carry the full weight of suggestion which is intended. Were it but for this reason I shall range myself among those who demand the maintenance of extensive classical studies as a preparation for those of medicine for the best means to uphold the prestige of the physician is still to raise him as far as possible above his contemporaries. Congrès Fran-

These words express, it seems to me, a large measure of truth. May it not be that in the tendency to the neglect of the humanities we are taking a false step? May it not be that if, on the other hand, we teach them earlier and better, we shall find in the end that no essential time is lost, while we shall gain for medicine men not only with minds abler to grasp the larger and broader problems, but with materially fuller powers for carrying on the humbler but no less important duties of the practitioner of medicine?

In that which I have just said I have touched upon the necessity of the requirement of a considerable amount of clinical experience as an essential for the license to practise medicine. To meet the enormously increased demands of the present day, medical education has become, of necessity, much more comprehensive, and must therefore extend over a longer period of time. The methods of research, anatomical, physical, chemical, which the student must master, the instruments of precision with which he must familiarize himself, are almost alarmingly multifarious; and experience in the application of these methods and in the use of these instruments demands increased time. Many of these proceedings, it is true, the physician will rarely be called upon to use personally in practise, for such measures must in great part be carried out by special students or in laboratories provided by the government. Nevertheless, with their significance and value he must be familiar—familiar from personal observation and experience.

But after all there are few diagnostic signs in medicine and not so many of the improved methods of clinical investigation yield diagnostic results, while to familiarize one's self with methods and instruments of precision is a very different matter from acquiring real experience and skill as a diagnostician or a therapeutist. It is only by gathering together and carefully weighing all possible information that one is enabled to gain a proper appreciation of the situation and approach a comprehension of many conditions of grave import to the patient. And in forming a sound judgment with regard to these vital questions, that which comes from experience in the close personal observation of the sick is far the most important element. Bedside experience constitutes to-day, as it always has, and always will, the main, essential feature in the training of the physician. But this experience if it is to bear its full fruit, must be afforded to the student at a time when his mind is still open and receptive and free from preconceived ideas —under conditions such that he may be directed by older trained minds into proper paths of observation and study, for few things may be more fallacious than experience to the prejudiced and the unenlightened.

That such experience may be freely offered to the student, there is a grave necessity for a more general appreciation, by institutions of medical training as well as by the powers in control of public and private hospitals and infirmaries, of the mutual advantages to be gained by a cordial cooperation. It must be acknowledged that, in this country at least, despite the cultivation of improved methods of clinical investigation, there still prevails in the mind of the public the perverted idea that this bedside observation, this application of new methods of research and study, are for the advantage of the student or in the interest of general science rather than for the benefit of the sufferer himself. It must further be recognized that a wholly mistaken conception of the true function of a hospital is widely prevalent. It is all too common to see large and ornate institutions

cais de médecine. VI. Session. Paris, 1902, 8°, T. II., p. xli.

with every arrangement for the comfort and even luxury of the patient, with a medical staff utterly insufficient in number or training to properly study the individual case, not to speak of carrying on scientific investigations—the service, usually under the direction of a busy, driven practitioner with barely time to make a short daily visit —large wards under the direct control of one or two young men whose time is wholly occupied by routine work—every care taken for the present comfort of the patient—little provision for enlightened study or treatment of his malady—no opportunities for a contribution on the part of the institution to the scientific progress of the day. Better far for the sufferer were he in the dingy ward of an old European hospital where he might be surrounded by active inquiring minds recording the slightest changes in his symptoms, ever ready to detect and, as far as the power in them lies, to correct the earliest evidences of perversion of function. What our hospitals need is men, students, whether or no they have arrived at the stage in their career—which, after all, is but a landmark, not a turning point—that entitles them to the right of independent practise, the enthusiastic, devoted student who, in watching and studying the patient, is contributing alike to the interests of the sufferer, the hospital and himself.

The three main functions of a hospital, the care of the sick, the education of the physician, the advancement of science, are not to be met alone by the building of laboratories and operating rooms and lecture halls, by the furnishing of the refinements of luxury to the patient, useful adjuvants though these may be. What the hospital mainly needs is men, men to study and think and work—*students of medicine.*

It can not be denied that in this respect we in America are behind our cousins of the old world. Despite our many honorable achievements, the part which we are taking in the modern study of the physiology of disease is still not what it should be.

Ere long we must come to realize that our duty to the sick man consists in something more than to afford him that which most sick animals find for themselves—a comfortable corner in which he may rest and hide from the world; that our duty to the public is to give them as physicians, men of the widest possible general training, ready to enter upon independent practise with an experience sufficient to render them safe public advisers; that our duty to ourselves is to miss no opportunity for the study of pathological physiology at the bedside of the patient; that the accomplishment of these ends depends in great part upon the appreciation by our universities and hospitals of the mutual advantages of cooperation in affording every opportunity for the scientific study of disease while offering to the patient the privileges of enlightened observation and care.

But there are everywhere signs of a future rich in achievement. An improving system of medical education, the increasing opportunities for scientific research offered as well by the generosity of private citizens as by the wisdom of state and national governments, the community of effort which results from closer fellowship among students of all nations, are omens of great promise. The remarkable developments of the last twenty years in all branches of the natural sciences have brought a rich store of suggestion and resource for application in our laboratory, which is at the bedside of the patient. Let us look to it that our clinical methods keep pace with those which are yielding so abundant a harvest in these neighboring fields of scientific research.

WILLIAM SYDNEY THAYER.

BALTIMORE.

THE TRAINING OF THE MINING ENGINEER.*

We are interested in the management of thirty-two mines, of gold, silver, copper, lead and tin. These mines are situated in Australia, New Zealand and elsewhere. In addition, we act for several exploration and development companies, which are engaged in other portions of the world. The thirty-two mines mentioned employ about 9,000 white men, and produce minerals of a gross value of 6,000,000 pounds sterling annually.

In the organization of these enterprises, each single mine is a unit of administration. The head of each unit is 'the manager,' who is not only necessarily a mining engineer, but he is also the commercial head of the enterprise, and, therefore, the dual capacity of technical and commercial execution is combined in one hand. This form of administration of mines causes mining engineering to differ in the requirements of training and experience from most other forms of enterprise where technical skill is required. Under the 'manager,' who has general charge of the mine, is a staff in charge of various departments. These men comprise a mechanical engineer, surveyor, electrician, metallurgist, chemist, foreman, accountants, etc., and, as in the case of the manager of the mine himself, these men are, except the accountants, of technical and semi-technical character, and have, as in his case, executive control of their departments, combining thus again the commercial and the technical administration into one hand. The number of 'superior' men employed varies with the size of the mine, from two technical subordinates, up to as many as fifteen or twenty on large mines. As said above, all of the staff except the accountant are necessarily men of more or less technical training. This technical training has been derived in foundation either from technical schools, or by self-education within the actual field of practise.

In addition to this organization of each unit, these mines are combined into administrative groups under a still superior organization, over which preside engineers of greater distinction and capacity. These men are themselves assisted by a staff of specialists in various departments, and who preside in a general way over all of the mines of their group and their particular departments, in reinforcement of the actual organization of each mine.

As the men thus employed in capacities superior to workmen are paid salaries varying with the importance of their position and their personal qualifications and experience, an easy method of discussion of the results of technical training can be arrived at by dividing them into classes according to their salaries. There are a total of 272 employees of this technical and semi-technical character (omitting accountants and purely commercial agents) in our employ.

The following table shows the number of men, arranged upon this basis, the character and origin of their training:

Class.	Trained in Technical Schools.				Trained in Practise.	Total.
	America.	Australia.	England.	Total.		
Salaries over £4,000	5	nil	nil	5		5
Salaries £1,200 to £4,000	9	1	2	12	5	17
Salaries £800 to £1,200	4	8	1	13	6	19
Salaries £480 to £800	3	19	3	25	37	62
Salaries £240 to £480	1	18	2	21	148	169
Total	22	46	8	76	196	272

In connection with the above, it may be observed that among men of the lower

* This essay is an extract from a private letter. It is published by permission of the author.

ranks, technical education is not so essential for the requirements to the position of assayer, cyanide man, mill man mechanical engineer, foreman, etc., are more of a skilled artisan than that of an engineer. A large portion of the men who fill these ranks are of this type, and have secured their training practically by way of apprenticeship through the actual work. These ranks, however, form the stepping stones from which all men must rise to the leading positions. It would be desirable if, except for some cases as foreman, all of this rank and file were men of the highest technical attainments, as, obviously, the men qualified to occupy superior positions are more advantageous in an inferior position than the man who has at that point reached his limitations.

From our experience and as indicated by practise shown in the table above, there can be no question as to our belief in the value of technical education. Given men of equal qualifications, the man of technical training is bound to rise to the higher position, because of his greater value to his employer.

A side issue in connection with the value of technical training lies in the fact that we have found, as a rule, men who have been technically trained are men by virtue of their education who are endowed with a professional feeling which does not to the same extent exist among those men who have risen from the rank and file. They are, therefore, more trustworthy and, especially in mining work, where such premium for dishonesty exists, for this qualification alone, they are bound to have precedence. We do not by any means wish to disparage the qualifications of many men who have risen from the ranks to eminent positions, but our opinion may be concentrated in the statement that even these men would be better men had they received a thorough technical training.

As to the character of the training which we should desire for men whom we would employ, we can make the following observations:

1. These men should receive a thoroughly broad groundwork of education in the humanities, as well as the sciences, prior to their entrance to technical schools.

2. Their technical training should extend over a period of at least four years, as we believe that any period less than this is quite insufficient in which to embrace the purely theoretical groundwork of the engineering profession which we should desire in our employees.

3. The character of this training should be altogether theoretical, subject to the intercalation of experience set out in paragraph 5. Four years is too short a time in which to embrace any 'practical' training within the working days of a technical institution. Mining engineering requires a broader training than any other engineering branch, as it must embrace mechanical, electrical and civil engineering, as well as applied chemistry and mineralogy.

4. The theoretical training during this period should cover a thorough training in pure science of mathematics, chemistry, physics, geology and mineralogy and mechanics, with special instruction in the applied branches of these sciences, as bearing upon this special branch of engineering. It is our belief that especial stress should be laid upon the purely scientific portion of this training, as under the varied conditions of each new problem this portion is of more use than any knowledge of special application.

5. During the course of theoretical training, in which there must obviously, in any educational institution, be certain vacations, as is done in American universities, in the actual employment of going concerns. Such employment should not be undertaken with a view to the actual ex-

perience gained, as fitting men for final employment on the expiration of the four years, but with a view to rooting in the minds of the men the use and application of the theoretical training which they are undergoing.

6. In the instruction of the applied features of these sciences, we do not believe in any attempt to reproduce actual working conditions, but that all laboratory work should be of a purely theoretical and investigatory character. As this is a disputed point, we may set out our reasons fully. They are:

(*a*) The time of young men in technical institutions can be more usefully employed in theoretical training than practical demonstration, and lack of such theoretical training can seldom be made up in after life.

(*b*) In mining engineering, as we have set out above, the qualifications necessary for our requirements are not only technical, but are also commercial. Men must take on administrative functions. It is impossible to reproduce commercial conditions in any training institution. It has been our universal experience with young men who have come from technical colleges where an attempt was made to give so-called practical instruction, that these men came to us in the thorough belief that they were fully fitted to occupy important positions. The conditions under which so-called practical instruction can be given in technical institutions, reduces them to purely play-house value and gives to the mind of the individual an exaggerated idea of his attainments.

7. Given the student having had four years of theoretical training, which has been founded on a preliminary entrance requirement of broad character, and a certain amount of vacation time spent in works, then this student should, for a period of at least two years, go into active employment of the nature of an apprenticeship. With this period, it should not be the ambition of the student to place himself in a fixed position, but rather to work through the various departments of such section of the industry as he intends to devote himself to, and to undergo this work as an actual workman. An opportunity of this character we are offering to students from the school of mines.

Upon receiving the men from technical institutions, we require them to spend two years or to have had two years' experience in the actual operation of the various departments of mining. In other words, to serve an actual apprenticeship as actual workmen in the various departments, as it is only by this that the youth can get an adequate balance of what constitutes commercial *vs.* theoretical conditions. In questioning the technically trained men employed in the most important positions on our staff, we find that in every single instance these men have served such an apprenticeship, yet we regret to say that in throwing our mines open to young men fresh from technical institutions, that not one out of ten have been content to go through this period of apprenticeship. A great majority has drifted entirely out of the profession. A few have secured positions beyond their capacities and come to worse grief.

In general, we may sum up the position that for our business what we desire are young men of good natural qualifications, thoroughly trained theoretically, without any so-called practical knowledge, unless this knowledge has been gained by employment in actual works, for, as expressed by one of the leading members of our staff, we have not the time nor the inclination to knock out of the heads of these men misimpressions which they have gained by so-called practical training in the technical school.

There are other matters in connection with this question which appear to be of more importance than the pure questions of technical training, and which are deeply rooted in English custom and feeling.

In the first instance, engineers have from time immemorial in this country (England) been educated by an apprenticeship to other engineers. The result has been more or less hand-to-thumb methods. This, of course, can be improved by direct technical training of the character given in America to engineers.

English industries, however, are conducted under two bureaus of administration—commercial and technical. The attitude of the commercial direction always tends towards the greatest immediate result, which usually takes the form of the least outlay of capital. The tendency of the engineer is to get the minimum production cost per unit, which involves large outlays of capital. Neither side is entirely right, and in America this has been successfully overcome by educating the commercial bureau as engineers. In other words, our engineers are administrators instead of consulting men, so that any improvement in English industries must come by a reorganization of their method of administration, as much as by superior education of their men, and this is a matter which can not be accomplished by technical education, and, in any event, would be of very slow growth. There are many hundreds of American engineers in the employ of English concerns, and almost universally they are in executive positions. The whole of the gold mining industry practically is under the direction of American engineers, and England owns mines yielding fully seventy-five per cent. of the gold output of the world, and the American form of administration has been introduced into this industry almost universally.

Another matter which enters into the great English question is that social dignity does not attach to the position of engineer. In the English social mind, the engineer is still an artisan or a tradesman, and the distinction of the engineer as a professional man of equal rank and personal attainments to any other profession has but few advocates in this country. The consequence is that the young men of better families, looking about for a profession, must choose either the law, the church, the army, the navy, medicine or the civil service if they hope to attain social dignity. The result is that it would be very difficult to draw the average brains of the country into the technical branches, whereas I think the feeling in America is quite to the contrary.

HERBERT C. HOOVER.

LONDON.

SCIENTIFIC BOOKS.

RECHERCHES SUR LES SUBSTANCES RADIOACTIVES.

OF the half dozen books which have recently appeared on radioactivity, two are of commanding importance, for they contain the records of the epoch-making work of the two investigators to whom we are most largely indebted for our present knowledge of the phenomena in question, E. Rutherford and Mme. Curie. Of these two wholly dissimilar treatments the former is the more comprehensive and perhaps the more suggestive; for, from beginning to end, it is a presentation of a well-developed theory of the cause and nature of radioactivity. Facts are everywhere grouped about, and fitted into, and interpreted in the light of this theory. On the other hand, Mme. Curie's 'Researches sur les Substances Radioactives,' now appearing in its second revised and corrected edition, deals very sparingly and very conservatively with theory. It is primarily a record of the experimental researches which have been made by herself and her husband during the past five years. Nevertheless, the work of other experimenters is given ample attention, so that the book constitutes a very complete and concise résumé of the present

state of our experimental knowledge of the subject.

The first chapter is a description of Mme. Curie's now well-known researches upon uranium and thorium compounds—researches which led (1) to the discovery of radium, polonium and actinium; and (2) to the announcement that radioactivity, whatever its nature, was an atomic property. This last announcement was based at first upon perhaps rather meager evidence, but it has since met with fuller and fuller confirmation. Nevertheless it still needs more complete investigation.

In the second chapter is found a description (which Madame Curie is of all persons most competent to give), of the methods which have been used in the separation from pitchblende of radium, polonium and actinium. The chapter concludes with an account of what is perhaps the most important work which has come from the hands of Madame Curie, viz., the determination of the atomic weight of radium. Any one who is familiar with the details of this work will be little inclined to credit the correctness of determinations which lead to values other than 225.

The third chapter deals with the nature of the radiations from radioactive substances—a subject in which Rutherford's experiments first brought order out of confusion, but to which the contributions of the Curies have been of but little less importance. The proof that the Beta rays impart negative charges to conductors upon which they fall, and the inverse proof that the body from which these rays emerge is left with a positive charge, were first made by Mme. Curie. Again, the study of the penetrating power of the Alpha rays of polonium, in which the important discovery was made that the fraction of the rays absorbed by various media increases with the thickness of the medium already traversed, was made first by the Curies. It is very difficult at present to reconcile this discovery with Becquerel's conclusion that the magnetic deviability of the Alpha rays diminishes with an increasing distance from the source. The third chapter contains also the important work in which M. Curie demonstrated the ionizing action of radium rays upon liquid dielectrics, and showed that this action is wholly independent of temperature. The chapter concludes with a description of the heating and luminous effects produced by radioactive substances—subjects in which the greater part of the knowledge which we now possess has come from the Curies.

The last chapter, upon induced radioactivity, is perhaps the least satisfactory of any in the book to the student who is not already thoroughly familiar with Rutherford's work on radioactive change, and on the nature of excited radioactivity; for he will be likely to find himself confused by a mass of disconnected facts. Madame Curie is evidently not yet completely converted to the disintegration theory of radioactive processes. She therefore adopts the conservative method of confining herself in the main to a presentation of the existing state of our experimental knowledge, leaving to the last three pages of the book the discussion of the various hypotheses which have been advanced to account for the emission of energy exhibited in radioactivity. Here she presents briefly the four following hypotheses, (1) Atomic disintegration of the radioactive substances; (2) transformation of gravitational energy; (3) absorption of some unknown form of ether energy; (4) atomic disintegration of other substances induced by the presence of a radioactive substance. Although she inclines less markedly than most of us toward the first, a leaning in that direction is nevertheless observable.

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University of Chicago,
October 19, 1904.

International Catalogue of Scientific Literature. First Annual Issue—L—General Biology. London, Harrison & Sons. 1903. Pp. xiv + 144.

This branch of the 'International Catalogue of Scientific Literature' is stated to include the following: "(1) Literature dealing with methods of work and investigation common to all branches of biologic science; (2) Literature dealing with the morphology, development or physiology of living organisms

in general, in so far as the differences between animals and plants do not enter into consideration; (3) Literature dealing with the study of the cell generally."

There are five main headings: 'General'; 'Methods and Apparatus'; 'General Morphology'; 'General Physiology'; 'General Cytology.' That the classification of subject matter is scarcely more than a beginning, is shown by the very small number of subheadings, only 87 numbers out of a possible 9,999 being used. Under 'General Morphology' there occur only four subheadings, namely: 'General'; 'Tectology (Structure of the Individual)'; 'Promorphology (Fundamental Principles of Structure)'; and 'Teratology'; which are numbered 1,000, 1,100, 1,200 and 1,500 respectively, all other numbers from 1,000 up to 2,000 being yet unfilled. 'General Physiology' and 'General Cytology' are somewhat more elaborated, but in the former there are only thirty-two subheadings, and in the latter only thirty-one, out of a possible four thousand in each case. It is easy to point out important omissions which might readily have been avoided. Such a voluminous subject as 'regeneration' is not mentioned. While 'senescence,' 'degeneration' and 'death' are all present, 'growth' is wanting. Physiological articles are found under both 'General Physiology' and 'General Cytology.' Some of the subjects which were pointed out in a previous review (SCIENCE, XIX., No. 493, p. 886) as absent from the branch of the catalogue devoted to physiology proper, are here found under 'General Cytology.' These include 'irritability' and 'fatigue,' but 'summation of stimuli,' 'rhythm,' 'specific energy' and 'automaticity' are omitted, while no mention is made of the tactic irritabilities. If articles on the physiology of the cell are to be indexed in both branches of the catalogue, it would seem to be the most logical and convenient arrangement to employ the same classification for both; but this method is not followed, and with the exception of cross references there seems to be no relation whatever between the two.

The present volume is supposed to include the literature published in 1901, together with a portion of that of 1902. Nine hundred and eighty-two articles are catalogued. The number of American journals is thirteen, of which the *American Naturalist* is credited to the United Kingdom. Cross references to other volumes of the catalogue are very numerous and tend to compensate for the incompleteness of the present volume.

The general impression left by an examination of the volume is that in its present form it is tentative and inadequate. It might easily be made a valuable adjunct to the volumes on botany, zoology, physiology and bacteriology.

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SOCIETIES AND ACADEMIES.

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

THE first regular meeting of the club for the year 1904–05 was held October 25, at 7:30 P.M., in the physical lecture room of Science Hall. Dr. V. Lenher gave an account of results obtained in a preliminary study of the gases dissolved in the water of Lake Mendota. It was shown that the amount of oxygen dissolved in the water of this lake decreases rapidly when the thermocline is reached, at a depth of about twelve meters, and that the carbonic acid in the water increases, so that while the surface water is faintly alkaline from dissolved calcium carbonate, the reaction of the water at this depth becomes acid.

The second paper of the evening, by Dr. S. Weidman, treated the subject, 'Wisconsin Iron-Ore Deposits,' with especial reference to the Baraboo district. The first year's shipment (1904) from the newly-discovered Baraboo district in Sauk County will probably reach 100,000 tons. The ore lies in the synclinal valley between the Baraboo quartzite ranges. The ore, associated dolomite, slate and quartzite are of pre-Cambrian age, like the formations in the Lake Superior iron districts. The valley is covered with upper Cambrian sandstone, and explorations are carried on by drilling through this formation. A number of good ore deposits have been

located, and the territory worthy of exploration is quite large. F. W. Woll,
Secretary.

DISCUSSION AND CORRESPONDENCE.

STOMACH STONES.

Those who have been interested in two recent papers concerning pebbles found with the remains of ancient reptiles, may like to read the following: About fifty years ago, some dozen or more hogs were enclosed in a pen which extended into a mill race. The hogs were fed entirely with ground feed in variety —meal, bran, corn and oats or sweepings—but no clover, grass or vegetables, so-called. When slaughtered, there were found in the stomachs of several of the animals, pebbles enough in each to fill the two hands of a man, as well as smaller quantities in some instances. In these cases, this habit was attributed largely to the peculiar diet of the pigs.

W. J. Beal.

To the Editor of Science: A number of instances are claimed of the retention at the present time of habits acquired in former geologic epochs in adaptation to conditions then existent but now changed, rendering the archaic habits to-day useless or even injurious. Such, for example, is the habit of certain migratory birds, in crossing the Mediterranean Sea, of following a line of 'extinct islands'; also the habit of the lemmings of Scandinavia of periodically seeking the 'lost island of Atlantis.'

Is it not *perfectly evident* that in the habit shown by seals and sea-lions of ingesting pebbles we have a retention of an ancient custom dating from the days when seals had gizzards? Maynard M. Metcalf.

THE METRIC SYSTEM.

To the Editor of Science: In the issue of Science of October 21, page 539, is a table of the height of African pygmies. This table is in British measures, and at the close of the article in which the table occurs is this statement: "In the writer's first description of these people in 1897 there occurs a mistake made in the conversion of the metric system to English measure."

Now I am not strictly an anthropologist, but I am interested in some features of the study, and when I take up the more substantial books on the subject, I find the measures given are metric. As physical culture is one of the points that interest me, it would be a great advantage to me if Mr. Verner had published his figures in metric terms. There would then have been no mistakes, and comparisons would have been much easier for those who approach the subject from the cosmopolitan standpoint.

Is it not about time that a paper like Science, which professes to represent the science of this country, should show a preference for the measures employed by almost all scientific workers—to the extent, at least, of printing all quantities in both systems as the medical papers often do? The matter is becoming more and more important every day. See, for example, the embarrassment caused by the two systems of measure in preparing a map of the world, *National Geographic Magazine,* October, page 407.

Wm. H. Seaman.

SPECIAL ARTICLES.

GOVERNMENT SUPERVISION OF HISTORIC AND PREHISTORIC RUINS.

The traffic in prehistoric wares from the southwest that has arisen during the past few years, with the attendant destruction of prehistoric remains, has become a matter of great concern to archeologists, who appreciate the gravity of this loss to anthropological science. Even though much of this material gathered by parties who are only commercially interested in it, eventually finds its way into public museums, its value to science is greatly reduced because of the absence of authentic records. Fortunately, a growing popular and educational interest in historic and prehistoric landmarks has arisen to assist in the preservation of these objects.

As a citizen of New Mexico who has watched with deep concern the loss of many of the incomparable archeological treasures of the southwest, I have recently taken up in a

more serious manner than ever before an inquiry into the question of how these monuments may be permanently preserved and prehistoric relics protected at least long enough to permit of their scientific investigation. During the past few weeks, while pursuing certain lines of research at the national capital, for which the splendid resources of various government departments, bureaus, museums and libraries have been most courteously placed at my disposal, the opportunity has been given me to inform myself fully as to the care which the United States government has exercised over these ruins, is now exercising and stands ready to exercise whenever properly informed. The manifest desire to be informed, and the promptness with which information is digested and acted upon by the departments having jurisdiction over such matters are most encouraging.

In view of the fact that scientific bodies have come to take a commendable interest in this subject, and that various measures looking toward the protection and preservation of our prehistoric ruins have been and now are under consideration and may be brought before the national Congress next winter, it will be helpful in considering such measures to know that a wise and vigorous policy has been developed in the department of the interior with reference thereto. This policy, if vigorously pursued, practically accomplishes the ends to be desired and renders legislation of secondary importance. The following correspondence explains itself. I give, first, excerpts from a letter from the Honorable W. A. Richards, Commisioner of the General Land Office, under date of October 5, 1904.

PROFESSOR EDGAR L. HEWETT,
WASHINGTON, D. C.

Sir: I beg to acknowledge the receipt of your letter of September 3, 1904, transmitting a memorandum relative to the historic and prehistoric ruins in Arizona, New Mexico, Colorado and Utah, and, also, of your letter, under date of September 14, 1904, in relation to proposed legislation for the protection of such ruins.

* * * * * *

This office fully appreciates the necessity for protecting these ruins and the importance of furthering in every way possible, researches in connection therewith which are undertaken for the benefit of recognized scientific and educational institutions, with a view to increasing the knowledge of such objects and aiding in the general advancement of archeological science; and it desires to aid all such efforts to the full extent of its power, while, at the same time, endeavoring to effectually protect the ruins and relics on the public lands from ruthless spoliation by parties plying a trade in such matters.

* * * * * *

The need for adequate legislation on this subject has, accordingly, been called to the attention of congress by this department for a number of years, but as yet without avail.

In the meantime, every effort has been made to extend such protection to the various regions known to contain objects of interest as is possible without the requested legislation. Certain of the tracts have been protected from appropriation by being temporarily withdrawn from disposal under the public land laws. This action has been taken in the following cases:

In New Mexico: The Pajarito Cliff Dwellers' region, the Jemez Cliff Dwellers' region, the tract known as El Moro, or Inscription Rock.

In Colorado: The Mesa Verde Cliff Dwellers' region.

In Arizona: The tract containing the petrified forest; the greater portion of that part of the district designated by you as the Rio Verde district which lies outside of the Black Mesa Forest Reserve. This withdrawn area contains, among other ruins, the one known as Montezuma Castle.

* * * * * *

As regards the regions which you mention as containing ruins of known importance, which fall within the boundaries of tracts that have been permanently set apart as forest reserves, or just outside of the boundaries thereof, you are advised that they are, in consequence, under the care of the forest force patrolling the reserves, and that instructions have, at different times, been issued to the forest officers in respect to having a general care of these ruins. Further and more specific instructions will now be given in regard to their care, based upon the information furnished by you.

The several regions thus under the supervision of the forest reserve force fall within the districts designated by you as follows:

In the Gila River Forest Reserve, New Mexico: The greater portions of both the Upper Gila District and the San Francisco River District.

In the Black Mesa Forest Reserve, Arizona: A portion of both the San Carlos District and the Rio Verde District; which latter contains what is known as Montezuma Well.

In the San Francisco Mountains Forest Reserve, Arizona: A portion of the Flagstaff District.

* * * * * *

As yet, owing to the lack of sufficient available funds, it has not been practicable to place custodians in charge of the numerous and widely scattered ruins throughout the southwest, except in the case of three localities in Arizona. These cases are: The Casa Grande ruin; the Walnut Cañon ruins, lying partly within the San Francisco Mountains Forest Reserve; the ruins of Cañon del Muerto, within the Navajo Indian Reservation.

It is evident that immediate and effective measures should be taken by the government to protect regions containing objects of such great value to the ethnological history of this country and to other scientific studies; * * *

I am also heartily in accord with your recommendation that, while many of the tracts containing ruins and other objects of interest need only to be temporarily withdrawn and protected until the ruins and objects thereon have been satisfactorily examined and utilized, yet, certain of the most important of these regions should be preserved permanently as national parks, and that a general law be enacted, authorizing the establishment of such parks, and making provision for their proper protection and management.

* * * * * *

(Signed) W. A. Richards,
Commissioner.

The following orders were sent out by the commissioner of the general land office a few days subsequent to the above correspondence:

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE, WASHINGTON, D. C.

October 15, 1904.

Mr. F. S. Breen,
Forest Supervisor,
Flagstaff, Arizona.

Sir: Your special attention is called to the historic and prehistoric ruins located in the San Francisco Mountains and Black Mesa Forest Reserves. As the ruins are almost entirely within said reserves, you are directed to exercise special care in their preservation. For your information in this matter I will state that there appears to be no special statute forbidding scientific research on the public lands, or requiring that permission shall be obtained before undertaking the same or removing objects of value from the public domain. At the same time, however, independent of positive legislative provision in the matter, the United States has all the civil remedies, whether for the prevention or redress of injuries, which individuals possess. And, since all unauthorized excavations upon public lands which tend to the injury of same or of ruins or relics thereon, or the removal of objects of value or of scientific or historic interest, are in the nature of trespass upon the lands, all such intrusion upon public lands renders the parties to the trespasses liable to prosecution.

It is, therefore, deemed advisable that all persons wishing to explore and make excavations of the ruins referred to, should secure permission from the department. This office appreciates the importance of aiding in every way possible all examinations and gatherings of objects of interest upon the public domain, which are undertaken for the benefit of recognized scientific and educational institutions, while, at the same time, endeavoring to effectually protect the ruins and dwellings on the public lands from ruthless spoliation by parties plying a trade in such matters.

You are hereby directed to use your best efforts to carry out the wishes of the department in this matter, and so instruct your subordinates.

Very respectfully,
(Signed) W. A. Richards,
Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE, WASHINGTON, D. C.

October 19, 1904.

Mr. Frank Grygla,
Special Agent, G. L. O.,
Santa Fe, New Mexico.

Sir: Your special attention is called to the subject of the unauthorized explorations and excavations of the historic and prehistoric ruins located upon the public lands for purposes of traffic in the curios, relics and objects of scientific and historic interest taken therefrom.

In order to prevent the further improvident spoliation and destruction of these ruins, and to restrict the explorations and excavations thereof to those made for the benefit of recognized scientific and educational institutions and objects, it is deemed advisable that all persons desiring to engage in such explorations shall secure permission therefor from the department before commencing their operations.

You will take prompt and appropriate measures to insure observance of the department's wishes

with respect to such of said ruins as may be upon public lands, including those temporarily withdrawn with a view to the creation of forest reserves, or for other purposes, in your territory, and you will render all practicable assistance to the forest reserve and Indian officers in their efforts to protect the ruins upon the lands under their supervision from unauthorized explorations and excavations.

If in any instance adequate protection to the public interests in connection with these ruins can not be obtained without recourse to legal proceedings, you will at once report the facts and the means of proving them to this office for consideration with a view to the institution of such proceedings. Very respectfully,

(Signed) W. A. RICHARDS,
Commissioner.

Identical orders were sent to all forest supervisors and special agents of the general land office in the southwest. These orders cover not less than three fourths of all the ruins of New Mexico, Arizona, Colorado and Utah.

On or near all the important ruins that are situated on lands controlled by the General Land Office which have been withdrawn either permanently or temporarily the following notice, printed in conspicuous type on large sheets of tough white cloth, is kept posted by range riders and other officers:

WARNING:
DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
WASHINGTON, D. C., May 24, 1904.

Notice is hereby given that these lands have been withdrawn, for public purposes, from settlement, entry, and other disposal.

All persons are prohibited, under the penalty of the law, in such cases provided, from committing thereon any trespass whatever, and from working in any manner whatever any injury, waste, or damage of any kind to these public lands and to the timber, natural curiosities, caves, ruins, objects of antiquity, or any other public property thereon, and from removing or in any way disturbing the same. W. A. RICHARDS,
Commissioner of the General Land Office.
Approved: E. A. HITCHCOCK,
Secretary of the Interior.

The following excerpts from a letter from Hon. A. C. Tonner, acting commissioner of Indian affairs, set forth the policy of that department on the same subject:

DEPARTMENT OF THE INTERIOR, OFFICE OF INDIAN AFFAIRS, WASHINGTON, D. C.
October 22, 1904.

EDGAR L. HEWETT, ESQ.,
WASHINGTON, D. C.

Sir: This office is in receipt of your communication of the 17th instant,

* * * * * *

In reply you are advised that this office has been and is fully alive to the importance of preserving the various ruins and remains of antiquity scattered throughout the southwest, and has heretofore issued stringent orders to many of the Indian officials in charge of the reservations to which you refer—especially to those in charge of the Navajo, Moqui and Hualapi reservations. Quite recently this office, in order to prevent the spoliation of the prehistoric ruins in the cañons of De Chelly and Del Muerto, recommended to the secretary of the interior that a custodian be appointed to have charge of the ruins in the said cañons, and authority was granted by the secretary therefor and the custodian is now on duty.

In view of your present request the officials in charge of the various Indian reservations to which you refer have, in letters of this day, been advised relative to preventing further injury to ruins and suppressing the traffic in prehistoric pottery which may be found on the reservations under their care.

Their attention has been invited to the previous instructions of the office relative to this matter and they have been requested to use their best endeavors to keep out intruders and relic hunters and to see that such of the remains of antiquity as may be located within the reserves under their respective charges are kept intact until such time as proper scientific investigation of the same may be had. Very respectfully,

(Signed) A. C. TONNER,
W.M.W.—L.M. *Acting Commissioner.*

Following is a copy of orders sent out from the office of Indian affairs October 22:

DEPARTMENT OF THE INTERIOR, OFFICE OF INDIAN AFFAIRS, WASHINGTON, D. C.
October 22, 1904.

JAMES B. ALEXANDER, ESQ.,
SUPERINTENDENT PIMA INDIAN SCHOOL,
SACATON, ARIZONA.

Sir:

* * * * * *

It has been and is the policy of this office to prevent all unauthorized persons from entering

Indian reservations and despoiling historic or prehistoric ruins and taking therefrom any relics or remains of antiquity whatever. To this end your predecessors in office or perhaps you have heretofore been advised of the wishes of this office in this respect and requested to take such action as might be necessary to the end that proper protection should be afforded in the premises and all spoliation of these valuable ruins be prevented.

* * * * * *

It is desired that you take this matter up and issue such orders or instructions and take such action as may be necessary to carry out the wishes of this office as heretofore expressed. Should you have Indian police under your charge, they should be properly cautioned and instructed. Further, reliable and trustworthy chiefs and headmen of the tribe might likewise be advised of the desire of this office to protect these remains of antiquity from being despoiled by curio hunters, etc., and directed to aid you so far as possible in the matter.

Should unauthorized persons be found on the reservation or reservations under your charge and engaged in the work of excavating or collecting relics, etc., they should be removed from the reservation and the facts in the case be reported to this office in full.

Very respectfully,

(Signed) A. C. Tonner,

W.M.W.—L.M. *Acting Commissioner.*

In reply to a letter addressed to Mr. W. H. Holmes, chief of the Bureau of American Ethnology, inquiring what steps were being taken by that bureau with a view to putting the Interior Department in possession of information that would be helpful in carrying out the policy of the department relative to the southwestern ruins, I received the following communication:

SMITHSONIAN INSTITUTION,
BUREAU OF AMERICAN ETHNOLOGY,
WASHINGTON, D. C.

November 19, 1904.

My dear Mr. Hewett:

I beg to acknowledge the receipt of your letter of the 16th instant, making inquiries regarding the steps now being taken by the Bureau of American Ethnology in furnishing information to the Interior Department relative to the location, character, and condition of the various historic and prehistoric ruins of the Southwest.

In reply I have to say that much progress has been made in the preparation of maps and descriptive lists of the various archeological sites of the Pueblo region. The Bureau has been conducting explorations among these sites at frequent intervals ever since its foundation, and has published numerous reports and maps embodying the results of its researches. The preparation of a general archeological map has been in hand for several years, and the data amassed is laid down on the Geological Survey maps, upwards of 50 of the topographical sheets covering parts of Utah, Colorado, New Mexico and Arizona having been utilized in this manner.

Accompanying the maps is a card catalogue of the sites, giving more or less complete data relative to the ruins and other remains. Recently a demand for this class of information has arisen in the Interior Department, and in order to properly meet this demand the work has been taken up afresh and reliable information from all sources is being brought together. The data previously collected is now being transferred to the latest editions of the maps on which we are laying down all Indian Reserves, private land grants, and township and section lines. Distinctive symbols are used for the various classes of remains, thus aiding in identification of particular sites; and the catalogue as recently remodeled, embodies a wide range of information, especially such as is likely to be of service to the Interior Department. The work is rapidly covering all the public lands on which archeological remains of importance occur and progress maps will soon be submitted for publication. Copies of these will, if deemed advisable, be placed in the hands of land surveyors, Indian agents, custodians of reservations, teachers, and others employed in the region or having knowledge of its ancient ruins, in order that all possible additions may be made.

It is expected that in a few years the record of our more important antiquities, already completed and published for the Mississippi Valley and the Gulf states, will be extended to cover the entire country.

I am enclosing herewith samples of the catalogue cards recently introduced. They provide spaces for recording data as follows: State, county, township, range, section, drainage; map (name of sheet), number of site, class or kind of remains, common or aboriginal name, where such exist, people, if known; needs of protection, of custodianship and repair; availability for research; history and bibliography.

The information thus gathered will be available for use by the Interior Department at an

early date, although the data with respect to many important sites will necessarily be imperfect.

Very truly yours,

W. H. HOLMES,
Chief.

MR. EDGAR L. HEWETT,
U. S. National Museum.

Identical orders were sent at the same time to superintendents of Indian schools, agents and additional farmers throughout New Mexico, Arizona and Colorado. These orders cover about one fourth of all the southwestern ruins. It will be seen that these various sets of orders from the two departments embrace practically all of the ruins that are not under private ownership.

It definitely mobilizes, so to speak, a force of forest supervisors, rangers, special agents, Indian school superintendents and teachers, Indian agents, farmers and police, and even enlists the Indians themselves, a particularly sagacious step, in the protection of these ruins for the avowed purposes of preserving them for scientific investigation. It establishes the broad and liberal policy that any competent scientist, who desires to place the material secured in a reputable public museum, will be authorized by the department of the interior to examine ruins, but that no person will be permitted to enter and excavate them for the purpose of acquiring specimens for traffic or private gain, and that willful destruction of valuable historic and prehistoric landmarks must cease.

Most archeologists will agree with Governor Richards that this subject calls for some judicious legislation, but they will be especially gratified to know that, pending such enactment, an efficient and economical policy has been developed in the department of the interior which is being made operative as promptly as circumstances will permit. The main thing, a system of governmental protection of archeological remains, is manifestly an accomplished fact, as much so, and after the same manner, as is the protection of timber on public lands. It will be effective just so far as the commissioners of the general land office and of Indian affairs are furnished with means adequate to carry the system into effect. It would now seem that all concerned can best serve the interests of science and of the public by upholding this wise policy. I would further suggest that all workers in the southwestern field should make it their duty to keep the department of the interior informed of violations of the above orders which come to their notice and that they should henceforth refuse to purchase for museums any specimens or collections that are not secured by parties duly authorized to collect the same by the secretary of the interior. A specimen not secured by legitimate authority and not accompanied by authentic record should have no place in a reputable museum.

The bill proposed by Commissioner Richards as a substitute for all the pending bills on the subject is embodied in his annual report for 1904 to the secretary of the interior which can doubtless be had by addressing him. I regard it as a sound measure which provides in a simple and direct way for the end to be accomplished, and which should precede any further special enactments.

EDGAR L. HEWETT.

LAS VEGAS, NEW MEXICO.

NOTES ON THE HISTORY OF SCIENTIFIC NOMENCLATURE.

THEOPHRASTUS REDIVIVUS.

ALL who delight in contemplating the extraordinary attainments of the Hellenic mind, whether expressed in art, literature or science, will rejoice at the appearance of Dr. Hugo Bretzl's learned treatise on 'Botanical Knowledge resulting from the Alexandrian Conquest.'* This work of over 400 pages unquestionably ranks as the most critical and thoroughgoing discussion extant of the earliest botanical contributions that have come down to us from the olden time.

Naturally, the chief sources of material are those furnished by the writings of Theophrastus, disciple of Plato and Aristotle, and successor of the latter. Additional information of great value, especially as regards the extinct mangrove colonies along the Red Sea and Persian Gulf, to say nothing of general natural history, is contained in those oldest

* 'Botanische Forschungen des Alexanderzuges,' Leipzig, 1903.

of nautical journals, the logs of Nearchus and Androsthenes—Alexander's admirals—portions of which have fortunately survived for 2,200 years.* All these ancient documents are remarkable for their absolute fidelity to nature, the accuracy of Theophrastus's descriptions leaving little room for doubt that this keen observer personally accompanied the famous expedition.

Notwithstanding the earlier commentaries of Scaliger, certain difficulties peculiar to Aristotelian writers have rendered Theophrastus largely unintelligible to modern students. These hindrances are partly of formal nature, partly due to the exceedingly colloquial style of description employed, and in still larger measure to the absence of illustrations and of a definite nomenclature. All the more gratifying is it, therefore, to find that most of the obscurities vanish before the penetrating analysis of philology, the original meaning becoming once more revealed like a restored palimpsest. The practical value of these researches consists in their disclosure of a means for identifying many of the species mentioned by Alexandrian botanists, which in turn provides us with important data in regard to plant distribution at a period more than two thousand years distant, together with changes in climatal and geographical conditions. Mention might also be made in this connection of Lenz's 'Botanik der alten Griechen und Römer' (Gotha, 1859), and of his 'Zoologie' (1856). A more popular recent work is Watkins's 'Gleanings from the Natural History of the Ancients (London, 1885).

WHAT IS A BRICK?

A BRICK is a rock. So a geologist has told us. Construction bricks, gold bricks, coal briquettes—possibly even ice cream bricks—all are rocks. Moreover, they belong to particular kinds of rocks. Careful investigations into the nature of 'bricks, plaster, concrete, cement and all other rocks which receive their characteristic features through man's agency' have enabled a writer in the *American Geologist* (33, p. 228, 1904) to dispel all doubt in the matter.

Among the clarifying conclusions reached by this purist we note that burnt bricks, as material, must be considered as æthobalic bioclastics.' Sun-dried bricks, plaster and cement fall harmoniously into the system as 'biolutytes'; concretes are 'biorudytes,' their texture being 'rudaceous'; and impure clay rocks, from which brick material is derived, are 'siliceous or calcareous anemoargillutytes.' As for the pure anemoclastics (*sic*), these are separated into 'anemosilicarenytes' and 'anemocalcarenytes' as easily as falling off a log. The whole scheme is adorably simple, and simply adorable—to all such as prefer new and pedantic terms to common English expressions.

With becoming modesty the author suggests that 'the compound terms here given may be found useful in descriptive writing, especially as they are almost self-explanatory.' That the word *almost* may cover a multitude of sins is apparent from the fact that over a score of pages are consumed in explaining these mellifluous compounds. It is a satisfaction to find ourselves at one with the author in his concluding observation, to the effect that 'stratigraphers will scarcely need terms more precise than those here given.'

LITHOPHAGI.

HOMER and Herodotus have immortalized the Lotophagi, Alexander's historians the Ichthyophagi; and it has been reserved for Dr. S. W. Williston (SCIENCE, No. 513) to leave 'not a shadow of doubt' that plesiosaurs belonged to the Lithophagi. Evidence of collectors seems to be convincing that pebbles were actually swallowed by plesiosaurs in large quantities; but we are inclined to think that even Swift's 'bold man that first eat an oyster'

* Theophrastus availed himself of both of these itineraries in the preparation of his treatise, as did also Strabo, Pliny and later writers. The narrative of Nearchus owes its preservation chiefly to Arrian, historian of the Macedonian invasion. Several English translations of the text are extant, and the points at which the fleet touched have been determined by Tomaschek and others. Copious notes on these and other ancient itineraries are given in M'Crindle's 'Ancient India as described in Classical Literature' (1901).

would have flinched before the 'gizzard' proposition.

Had Dr. Williston stated his syllogism as follows: 'All birds have feathers; the sage hen is a bird; therefore the sage hen has feathers'—he would have substituted the exact converse of our argument with respect to reptiles. Negative evidence is, of course, unconvincing, and there are paleontologists who may say: 'It is conceivable that some reptiles had feathers, though none are now known to possess them; therefore, it is possible that plesiosaurs (and other reptiles) had feathers.' To them we answer, it is also *possible* that plesiosaurs rejoiced in having a vermiform appendix; and the author* who recently described a specimen of *Hybodus* with a school of Belemnites inside, might have gone a step further than he did, postulating appendicitis as cause of death. As it was, we shall hardly contest his verdict in pronouncing it acute indigestion: 'bei der Verdauung traten dann Beschwerden ein.'

INTRODUCTION OF THE TERMS GEOLOGY AND PALEONTOLOGY IN NATURAL SCIENCE.

THE opinions of so eminent an authority as Dr. S. F. Emmons are entitled to universal esteem. When this learned writer tells us in SCIENCE (No. 512) that he 'should have considered it a useless waste of time to have searched all ancient literature to find out by whom it [the term geology] was first used,' most of us will cheerfully agree with him.

When, however, he reiterates the statement that 'de Saussure was the first *geologist* to use this term' in its modern acceptation, only a moment's time is required to satisfy one's self of its historical inaccuracy. In the work of von Zittel to which Dr. Emmons refers (page 106 of the German edition), the credit for having introduced the term geology in a scientific sense is awarded to Deluc (1778). Deluc and de Saussure were contemporary scientists, but the employment of the term geology by the former antedates that of the latter.

If one can spare a moment further, still without 'searching all ancient literature,' one may consult a standard authority like Murray's 'New English Dictionary' (Oxford). Under 'geology' the earlier use of the term by de Bury in 1344, and by F. Sessa in 1687, is referred to, after which it is remarked: 'So far as at present known, the use of the word as a name for a distinct branch of physical science occurs first in English,' references being given to E. Warren (1690), B. Martin (1735) and Bailey (1736). Von Zittel is also authority for the statement that the term paleontology was introduced almost simultaneously by de Blainville and Fischer von Waldheim during the third decade of the nineteenth century.

COSMOGRAPHICAL KNOWLEDGE OF THE ANCIENTS.

THE appearance of a revised edition of Hugo Berger's 'History of Comparative Geography amongst the Greeks' furnishes occasion for a brief notice of this exceedingly valuable repository of information.* Of wider scope, yet more compact than Bunbury's and other standard histories of ancient geography, the plan of the present work aims to provide an epitome of all the essential facts, together with a profusion of references to original sources, and to commentaries upon the same.

Although dealing primarily with descriptive geography in the pre-Christian era, the subject necessarily includes cosmical, geological and physiographic aspects of earth-science in general; and from this it follows that the attempt to trace interrelations between authors belonging to different periods and schools, with the aid of our present materials, is an intricate task. Herein probably lies the explanation of the numerous repetitions and cross-references which occur throughout the work, a feature which is no less conspicuous in Humboldt's 'Cosmos' and similar treatises.

The critical acumen of the author may be best appreciated through comparison of judgments passed by him upon this or that heroic figure in science, compiler, or commentator, with the judgments already passed upon them by equally erudite explorers of the same field. Divergence of opinion is to be noted in many

* Campbell Brown, 'Ueber das genus Hybodus,' etc., Palæontogr., **46**, p. 163 (1900).

* 'Geschichte der wissenschaftlichen Erdkunde der Griechen' (Leipzig, 1903), pp. 662.

cases, sometimes flat contradiction; but it is safe to say that wherever Dr. Berger gives his individual estimate of ancient wayfarers along the road to knowledge, he has formed his opinion from profound and conscientious study.

The subject-matter of the work is arranged chronologically according to authors, and as the latter are generally occupied with a surprising variety of topics, the historical continuity of certain lines of investigation becomes obscured by this method of presentation. A remedy for the defect would have been to summarize in special chapters the progress made in the study of particular phenomena, such as the cosmical relations and movements of the earth, volcanic activity, tides, petrifactions, and the like. Tozer's 'History of Ancient Geography' is arranged partially after this fashion, and is excellently adapted, by the way, as an introduction to the work above considered.

C. R. Eastman.

Harvard University.

BOTANICAL NOTES.

THE STUDY OF PLANT DISEASES.

An interesting pamphlet comes from the antipodes under the title of 'Letters on the Diseases of Plants,' by N. A. Cobb, of the Department of Agriculture of New South Wales. In somewhat over a hundred and thirty pages the author has brought together the substance of a great number of letters written in reply to correspondents. He has recast the matter so that the epistolary form has been obliterated, and he has added a large number of cuts in the text, and a dozen full-page plates (some colored). Here in compact form is to be found a great deal of information in regard to many plants, stated in such non-technical English as to render it easily comprehensible by any intelligent person. There is first a long discussion of ripe rot, the fungus of which (*Glœosporium fructigenum*) attacks the fruits of many different plants. The results of many interesting experiments are given in detail. Banana seab (*Phoma* sp.), stigmonose (due to insect punctures), mouldy core of the apple (*Penicellium, Mucor* and others), quince rots, peach curl (*Exoascus deformans*), lemon and orange diseases, diseases of the passion vine, potato diseases, root-rots and timber rots, are among the topics more or less fully treated in this valuable publication.

THE STUDY OF WOODS.

Another book on the structure and uses of the woods of commerce has made its appearance in England under the title of 'The Timbers of Commerce, and their Identification.' It is from the hand of Herbert Stone, F.L.S., and is issued by Rider & Son, of London. It constitutes a neat volume of about 350 pages, and is beautifully illustrated with 186 photographs showing the grain of cross and longitudinal sections of wood. There is a general introductory chapter on the structure of wood, and following this are the descriptions of 247 different species. These descriptions are very concise, a short paragraph (or line) being given to each of the following topics: Natural order, synonyms, sources of supply, alternative names, physical characters, grain, bark, uses, etc., authorities, color, pores, rays, rings, soft tissue, pith, radial section and tangential section. There is a good deal of similarity between this book and the one prepared by Professor Snow last year under the title of 'The Principal Species of Wood,' and noticed in these columns (Science, July 3, 1903), at the time of its appearance. The American book takes up only about half as many species as the English book, and its descriptions are shorter, covering fewer points, yet the much better arrangement and the careful selection of species in the former make it by far the more useful for the American student or artisan.

COMPARISON OF EASTERN AND WESTERN FLORAS.

The recent publication of two local floras permits a comparison between an eastern rocky area with one consisting of typical prairie conditions. George G. Kennedy's 'Flora of Willoughby, Vermont,' originally published in *Rhodora* for June, 1904, takes up the plants of Willoughby Mountain, Willoughby Lake and the vicinity, in northern Vermont. The elevation of the lake above the sea is 1,060 feet,

while the summit of the mountain is 2,650 feet. The list includes 570 native and 120 introduced species.

R. S. Cratty's 'Flora of Emmet County, Iowa,' enumerates the plants of a prairie area in northern Iowa. Here the surface is gently rolling, and there are no rock exposures within the county. The general surface has an elevation of about 1,500 feet above the sea, and its latitude is within a couple of degrees of that of the area covered by Mr. Kennedy's list. Mr. Cratty's list includes 532 native and 58 introduced species. Comparing the two we find that there are 42 species of trees in the Willoughby flora, and 31 in Emmet County. The representation of the principal families and larger groups is as follows (introduced species are given after the plus sign (+)):

	Willoughby.	Emmet.
Pteridophytes	63	9
Gymnosperms	9	1
Naiadaceæ	8	13
Vallisneriaceæ	1	2
Gramineæ	40+22	54+9
Cyperaceæ	76	53
Juncaceæ	11	6
Liliaceæ	15+3	15+1
Orchidaceæ	27	5
Salicaceæ	12	11
Betulaceæ	8	2
Fagaceæ	2	2
Ulmaceæ	2	3
Polygonaceæ	4+8	13+2
Chenopodiaceæ	1+1	2+2
Caryophyllaceæ	1+1	3+3
Nymphæaceæ	3+1	2
Ranunculaceæ	14+4	21
Cruciferæ	7+10	10+7
Rosaceæ	19	15
Pomaceæ	6+1	5
Drupaceæ	4	3
Cæsalpiniaceæ	0	1
Papilionaceæ	2+7	23+6
Euphorbiaceæ	0+1	2
Aquifoliaceæ	2	0
Hypericaceæ	5+1	2
Violaceæ	11+1	3
Umbelliferæ	6+3	11+2
Cornaceæ	4	5
Ericaceæ	22	0
Gentianaceæ	2	5
Asclepiadaceæ	1	8
Boraginaceæ	1	4+1
Verbenaceæ	0	3
Labiatæ	10+7	14+2
Solanaceæ	1	3+2
Scrophulariaceæ	3+3	14+1
Rubiaceæ	6	5
Caprifoliaceæ	10+1	6
Campanulaceæ	4+1	4
Compositæ	64+21	70+10

The small representation of Pteridophytes, Gymnosperms, sedges, orchids, violets and Ericaceæ, in Emmet County, and the larger numbers which it has of Naiadaceæ, native Gramineæ, native Polygonaceæ, Papilionaceæ, Verbenaceæ, Solanaceæ, and native Compositæ, are remarkable.

TREES AND SHRUBS IN CANADA.

A RECENT bulletin (47) issued by the Canadian Department of Agriculture contains the results of a large number of trials of trees and shrubs which have been planted at the experimental farms at Brandon and Indian Head, situated respectively in the provinces of Manitoba and Assiniboia. These farms are on the Great Plains of Canada, near latitude 50° north. After sixteen years of testing a large number of species, the following are the more important trees and shrubs which have proved quite hardy: box elder, Tartarian maple, western June-berry, paper birch, Siberian pea-tree, Siberian dog-wood, red-osier dog-wood, hazel-nut, hawthorns (several species), broom, Russian olive, green ash, honeysuckles (several species), balsam poplar, cottonwood, black poplar, aspen, western wild cherry, pin-cherry, Canada plum, Siberian crab-apple, mountain ash, bur-oak, buckthorn (several species), smooth sumach, roses (several species), willows (several species), buffalo berry, spiræas (several species), snowberry, lilacs (several species), white elm, white spruce, black spruce, Engelmann's spruce, blue spruce, jack pine, stone pine, Scotch pine, Riga pine and tamarack. The bulletin must prove most useful for Canadian planters.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

A NOTE ON WESTERN FARM VALUES.

NORTHERN and eastern Iowa comprise one of the most highly developed agricultural dis-

tricts in the entire west. The features of the system of farming which separate this from other sections are complete crop rotation and maintenance of soil fertility by means of live stock. Dairying and stock raising have a firm place in one of the most completely developed systems of cultivation in the Mississippi valley. In essential respects this section is comparable to the system of farming to be found at its best in eastern Pennsylvania, especially in the Susquehanna valley. Since 1895 prices of land have gone up throughout the central and northwestern states, to a level which no one could possibly have anticipated. Farm lands in Illinois (west central) sell from $100 to $150 per acre, along the route of the C. B. & Q. R. R. The tenant pays a rental of from $5.00 to $7.00 per acre and has made money at that. But he has in all probability not made money enough to induce him to invest it in farm lands there. The value of lands has reached a point at which he can earn more on his capital as a tenant than as an owner of high-priced lands. Consequently tenantry and landlordship are on the growth with the rise of the purchase price of agricultural lands.

One explanation of this rise in land values is the presence of surplus capital in the hands of farmers. A farmer who had his farm nearly or entirely paid for before the rise of farm prices since 1895 has been able, as a rule, to put money in the bank year by year. If he has not put it into securities which the financial centers of the country manufactured for consumption by the money-making public, he naturally may be expected to avail himself of opportunity to buy land as it comes into the market. This form of interest he knows something about, and he puts his savings in it regardless of the low rate of returns he knows he must get. But he knows it is sure. Take a corresponding case in land values in Pennsylvania. Farms are being sold in much of the most improved portion of that state at prices which represent little more than the value of the improvements. Farm land in a high state of cultivation is valued at less than has been the case for some years. Productivity has not declined and prices have improved with the general rise of agricultural prices. Where then does the cause for the difference in values in western and eastern farming lands lie?

John Franklin Crowell.
Washington, D. C.

THE NATIONAL ACADEMY OF SCIENCES.

The autumn meeting of the National Academy of Sciences was held at Columbia University on November 15 and 16. No business of general interest was transacted at the scientific session. The papers presented were as follows:

W. H. Dall: 'Biographical Memoir of Charles Emerson Beecher.' (By title.)

W. K. Brooks: 'On the Affinities of the Pelagiac Tunicates.' (Illustrated by lantern slides.)

W. K. Brooks and S. Rittenhouse: 'The Life History of *Turritopsis*.' (Illustrated by lantern slides.)

W. K. Brooks and R. P. Cowles: '*Phoronis architecta*, its anatomy, life history and branching habits.' (By title.)

John Trowbridge: 'On the Electrical Resistance of a Vacuum.' (Illustrated by lantern slides.)

Franz Boas: 'Psychic Association in Primitive Culture.'

M. I. Pupin: 'Time Electrical Impulses.' (Introduced by R. S. Woodward.)

C. Barus: 'The occurrence of maxima and minima of atmospheric nucleation in approximate coincidence with the winter and summer solstices respectively.'

C. A. Bauer: 'The System of Magnetic Forces causing the Secular Variation of the Earth's Magnetism.' (Introduced by R. S. Woodward).

Russell H. Chittenden: 'The Influence of Low Proteid Metabolism on the Formation and Excretion of Uric Acid in Man.' (Illustrated by lantern slides.)

Edward W. Morley: 'Note on the theory of experiments to detect the second power of the aberration of light.'

Edward W. Morley: 'Report of a repetition of the Michelson-Morley experiment on the drift of the earth through the luminiferous ether.

C. S. Peirce: 'On Topical Geometry.'

N. Yatsu: 'An Experimental Demonstration of the Formation of Centrosomes *de novo*.' (Presented by E. B. Wilson.)

T. H. MORGAN: 'An Analysis of the phenomena of Organic Polarity.' (Introduced by E. B. Wilson.)

E. B. WILSON: 'Experiments on Prelocalization in the Annelid Ovum.'

C. E. MENDENHALL: 'The absolute value of the Acceleration of Gravity determined by the Ring-Pendulum Method.' (Presented by R. S. Woodward.)

R. S. WOODWARD: 'The Double Suspension Pendulum for measuring the Acceleration of Gravity.'

EDGAR F. SMITH: 'Biographical Memoir of Robert Empie Rogers.' (By title.)

CHARLES F. HASTINGS: 'A Determination of the Dispersive Power of the Human eye.'

CHARLES F. CHANDLER: 'The Air in the New York Subway.'

SCIENTIFIC NOTES AND NEWS.

THE Hotel Walton, Locust and Broad Sts., Philadelphia, has been chosen as the headquarters of the American Association for the Advancement of Science and affiliated societies, for the meeting that opens at the University of Pennsylvania, on Wednesday, December 28.

THE seventeenth winter meeting of the Geological Society of America will be held at Philadelphia, beginning on December 29. The meeting will be called to order by President J. C. Branner, at 10 o'clock.

THE Royal Society has awarded its Rumford medal to Dr. Ernest Rutherford, professor of physics at McGill University, for his researches on radioactivity.

M. PERROT, professor of pharmacology, University of Paris; M. Henri Moissan, professor of chemistry, University of Paris; K. H. F. Rosenbusch, professor of mineralogy and geology, University of Heidelberg; Otto Bütschli, professor of zoology and paleontology, University of Heidelberg; Wilhelm Ostwald, professor of chemistry, University of Leipzig; Wilhelm Pfeffer, professor of botany, University of Leipzig, have been elected corresponding members of the Vienna Academy of Sciences.

THE Rev. Stephen D. Peet, editor of the *Antiquarian,* has been elected a corresponding member of the Anthropological Institute of Great Britain and Ireland.

ON the evening of November 14, a dinner was given in Cambridge to Sir John Murray and Professor Albrecht Penck, of Vienna, a number of professors and students of Harvard University being present.

DR. J. K. SMALL, curator of the Museum of the New York Botanical Garden, is in Florida studying the flora of that region.

UNDER the auspices of the Corporation of Newbury, a public museum was formally opened in that borough, on October 26, by Mr. Jonathan Hutchinson, F.R.S.

SIR JOHN BURDON-SANDERSON, F.R.S., has been made a perpetual delegate of the University Museum, Oxford.

THE following is a list of fellows who have been recommended by the president and council of the Royal Society for election into the council for the year 1905, at the anniversary meeting to be held in November 30: *President,* Sir William Huggins, K.C.B.; *treasurer,* Mr. Alfred Bray Kempe; *secretaries,* Professor Joseph Larmor, Sir Archibald Geikie; *foreign secretary,* Mr. Francis Darwin; *other members of the council,* Dr. Shelford Bidwell, Mr. George Albert Boulenger, Colonel David Bruce, R.A.M.C., Mr. Frank Watson Dyson, Professor Percy Faraday Frankland, Professor Francis Gotch, Dr. Ernest William Hobson, Professor John Newport Langley, Mr. John Edward Marr, Sir William Davidson Niven, K.C.B., Professor William Henry Perkin, Jr., Professor John Perry, Mr. Adam Sedgwick, Dr. William Napier Shaw, Professor William Augustus Tilden, Rear-Admiral Sir William Wharton, K.C.B.

PROFESSOR E. SALKOWSKI, director of the chemical department of the Pathological Laboratory of the Charity Hospital at Berlin, well known for his work in physiological chemistry, celebrated his sixtieth birthday on October 11.

PROFESSOR THEOBALD SMITH, of Harvard University, will deliver an address upon 'The Place of Research in the University Medical School,' before the Harvard Medical Society of New York City, at the New York Academy of

Medicine, on Saturday, November 26, at 8:30 P.M.

On November 17, Dr. H. W. Wiley addressed The New York Academy of Medicine, on 'The Influence of Preservatives in Foods on the Public Health'; on November 18, the College of the City of New York, on 'The Attitude of the Consumers towards Purity of Foods'; on November 22, The National Union, a fraternal insurance organization at Detroit, Mich., on 'Food-Quantity and Quality.'

At the Royal Institution, London, a Christmas course of lectures, adapted to a juvenile audience, will be delivered by Mr. Henry Cunyngham, C.B., on 'Ancient and Modern Methods of Measuring Time' (experimentally illustrated). The dates of the lectures are: December 27, 29 and 31 and January 3, 5 and 7.

The British Academy commemorated the bicentenary of the death of Locke, on October 28. Papers by Professor Campbell Fraser, on 'Locke as a Factor in Modern Thought,' and by Sir Frederick Pollock, on 'Locke's Theory of the State,' were read by the secretary in the absence of the authors.

Dr. Thomas Messinger Drown, president of Lehigh University and previously professor of chemistry at Lafayette College and the Massachusetts Institute of Technology, died on November 16 at the age of sixty-two years.

Mr. Frank McClean, F.R.S., a well-known British engineer and astronomer, died on November 8, at the age of sixty-six years.

The Massachusetts Institute of Technology has been awarded six prizes for its exhibit at the St. Louis Exposition. The awards are as follows: Grand prize for general exhibit, gold medal for mining engineering exhibit, silver medal for special exhibit of drawing, silver medal for special exhibit of photography, students' work, etc., and a bronze medal for a special exhibit of transparencies.

Columbia University has been awarded prizes at the St. Louis Exposition as follows: Grand prizes to Columbia University, for its general exhibit, and to President Butler for twenty educational monographs entitled 'Education in the United States.' Gold medals to the Department of Botany, for its special exhibit; to the Departments of Mining and Metallurgy, for their special exhibits; to Teachers College, for its special exhibit; to Professor J. McKeen Cattell, for his monograph on Scientific Societies and Associations; and to Professor Edward Delavan Perry, for his monograph on The American University. Bronze medals to the Department of Indo-Iranian Languages for its special exhibit.

Hobart College has been awarded a gold medal for its astronomical exhibit at the World's Fair. The distinguishing feature of the astronomical exhibit was a photographic collection of the cometary discoveries, now twenty-four in number, made by Professor Brooks.

The New York *Evening Post* states that the Peabody Museum, of Yale University, has received a collection of Indian relics from Christopher Wren, of Plymouth, Pa. The collection includes Indian pestles, scrapers and other utensils. Professor Schuchert, the new head of the museum, is planning an extensive relabeling and reclassification of the objects in the museum by which, for one thing, the vertebrate fossils will be grouped together, and, as far as possible, arranged topographically.

The Free Museum of Science and Art of the University of Pennsylvania has received a gift of several rare collections of North American Indian relics from Messrs. John Wanamaker and Thomas Donaldson.

The Royal Institution, London, has received a gift of £750 from Ludwig Mond and a bequest of £100 under the will of Miss Harriet J. Moore.

An American Forest Congress, under the auspices of the American Forestry Association, will meet in Washington, January 2 to 6, 1905, under the presidency of James Wilson, secretary of agriculture. The sessions of the congress will be held in the National Rifles Armory. On the afternoon of January 5, President Roosevelt and other prominent men will address a special meeting in the Lafayette Theater. The subjects to be considered at the congress are: (1) Relation of the Public Forest Lands to Irrigation; (2) Relation of

the Public Forest Lands to Grazing; (3) The Lumber Industry and the Forest; (4) Importance of the Public Forest Lands to Mining; (5) Forestry in Relation to Railroad Supplies; (6) National Forest Policy; (7) State Forest Policy.

THE twelfth National Irrigation Congress held its annual session last week at El Paso, Texas, under the presidency of Senator Clark.

AT a meeting of the council of the Michigan Academy of Sciences, held on November 12, the date of the next meeting was set at March 31 to April 1, and the place Ann Arbor.

AT the 23d annual meeting of the Natural Science Association of Staten Island the following were elected officers for the ensuing year: *President,* Howard R. Bayne; *secretary,* Arthur Hollick; *treasurer,* J. Blake Hillyer; *curator and librarian,* C. A. Ingalls.

THE fourth volume of Professor Moritz Cantor's 'Vorlesungen über Geschichte der Mathematik' will contain the history of mathematics for the period of forty years, from 1759 to 1799. The preparation of the volume is divided up among different authors as follows: (1) 'Geschichte der Mathematik, Klassikerausgaben Wörterbücher,' von S. Günther (München); (2) 'Lehrbücher der Elementargeometrie, Praktische Geometrie (Feldmesskunst), Elementargeometrische Einzeluntersuchungen Parallelenlehre,' von V. Bobynin (Moskau); (3) 'Trigonometrie, Polygonometrie, Tabellen (trigonometrische, logarithmische und andere)' von A. v. Braunmühl (München); (4) 'Rechenkunst und Buchstabenrechnung, Algebra (Lehre von den Gleichungen) Zahlentheorie,' von F. Cajori (Colorado Springs); (5) 'Reihen, Kombinatorik, Wahrscheinlichkeitsrechnung Imaginäres,' von E. Netto (Giessen); (6) 'Analytische Geometrie der Ebene und des Raumes,' von V. Kommerell (Reutlingen); 'Darstellende Geometrie,' von G. Loria (Genua); (7) 'Lehrbücher der Infinitesimalrechnung, Einzeluntersuchungen der Infinitesimalrechnung, Bestimmte Integrale Transzendenten,' von G. Vivanti (Messina); (8) 'Totale und partielle Differentialgleichungen, Variationsrechnung Differenzen- und Summenrechnung,' von C. R. Wallner (München); (9) 'Entwickelung der Mathematik zwischen 1759 und 1799, Geschichte der Ideen in diesem Zeitraume,' von M. Cantor (Heidelberg).

THE statutory annual meeting of the Royal Society of Edinburgh was held in the Royal Institute, Edinburgh, on October 31, Lord M'Laren presiding. The following members of the new council were elected: *President,* Lord Kelvin; *vice-presidents,* Professor James Geikie, Lord M'Laren, the Rev. Professor Flint, Dr. Robert Munro, Sir John Murray and Dr. R. H. Traquair; *general secretary,* Professor George Chrystal; *secretaries to ordinary meetings,* Professor Crum Brown and Professor D. J. Cunningham; *treasurer,* Mr. P. R. D. Maclagan; *curator of library and museum,* Dr. Alex. Buchan; *councilors,* Dr. John Horne, Mr. C. G. Knott, Professor R. Stockman, Professor James Walker, Professor Andrew Gray, Mr. Robert Kidston, Dr. D. Noel Paton, Professor John Chiene, Professor J. Graham Kerr, Mr. William Peddie, Dr. Leonard Dobbin and Professor J. C. Ewart.

UNIVERSITY AND EDUCATIONAL NEWS.

THE daily papers state that it is proposed to move the Western University of Pennsylvania from the suburbs of Allegheny to Pittsburg proper, near the new Carnegie Technical School. About fifty acres of ground, sufficient for twenty large university buildings, is being secured at a cost of about $2,000,000, and the work of construction will be begun before long. Fifty citizens of Pittsburg have agreed to give each from $40,000 to $100,000 for the school. The contribution of Mr. Carnegie has not been announced.

THE general assembly of the state of Vermont has appropriated $60,000 for the use of the agricultural department of the university. The money is to be expended in the erection and equipment of a building to be known as Morrill Agricultural Hall, in memory of the father of the agricultural colleges of the country, the late Senator Justin S. Morrill. The building will be devoted to instructional and experimental work in agriculture.

COLUMBIA UNIVERSITY, by a decision of the Court of Appeals, will take possession of real estate bequeathed by Stephen W. Phœnix, of New York, and yielding an annual rental of about $10,000. The bequest was contested by Mr. Phœnix's family.

A STATEMENT has been issued by the rector of the Catholic University announcing that no part of the $100,000 collected for the university last year has been lost through the failure of the treasurer. The amount that the university has lost or is liable to lose is not, however, stated. It seems extraordinary that a university should loan its endowment fund at six per cent. interest to an individual who used the money for real estate speculations.

C. P. CHASE, treasurer of Dartmouth College, announces the gift of $1,000 by the Earl of Dartmouth to the fund for the rebuilding of Dartmouth Hall.

THE preliminary register of the Johns Hopkins University shows the total enrolment to be 740, against 696 at the same period last year. This is the largest enrolment in the history of the institution. The faculty, including assistants and lecturers, numbers 160, a gain of ten over last year. There are 291 candidates for the degree of M.D., compared with 275 last year, the total number of graduate students being 556, an increase of sixteen over the year preceding. Undergraduate students number 186, a gain of 17 per cent. over the enrolment at the same time last year. Candidates for the A.B. degree next June number thirty-three.

THE department of geology, of the University of Chicago, has arranged for the following special courses to be given during the winter and spring quarters of 1905:

January 2–February 10.—(1) Courses in Non-metallic Economic Geology, by E. R. Buckley, Ph.D., state geologist of Missouri. (*a*) An elementary outline course; (*b*) An advanced course on structural materials.

February 13–March 24.—(2) Courses on Pre-Cambrian Geology, by Professor C. K. Leith, University of Wisconsin. (*a*) The Archeozoic and proteozoic Formations; (*b*) Laboratory course on metamorphic rocks, accompanying the above.

April 3–May 12.—(3) Courses on Ore Deposits, by F. L. Ransome, U. S. Geological Survey. (*a*) An elementary course on ore deposits in general; (*b*) An advanced course on gold, silver, copper and lead (in part) ores.

DR. CHARLES W. DABNEY was installed as president of the University of Cincinnati on November 16. His inaugural address was entitled 'Democracy and the School.'

MR. CLIFTON D. HOWE, assistant in botany in the University of Chicago, has been appointed instructor in botany in the Biltmore Forest School, Biltmore, North Carolina, and will begin his new duties on January 1.

WE learn from the *Electrical World* that Dr. F. A. C. Perrine, chief engineer of the Standard Electric Company, of California, has become a member of the faculty of the Polytechnic Institute of Brooklyn. Dr. Perrine will affiliate with the department of electrical engineering as consulting professor in long distance electric power transmission. Dr. Louis Duncan has been appointed consulting professor of electric traction. Dr. Duncan was the organizer and head of the department of electrical engineering at Johns Hopkins University, and recently reorganizer of the department of electrical engineering at the Massachusetts Institute of Technology.

MR. T. D. A. COCKERELL has been appointed lecturer on entomology in the University of Colorado, Boulder.

PROFESSOR JAMES ROBERTSON, commissioner of agriculture and dairy of the Dominion of Canada, has resigned from the government service and will take charge of the agricultural college to be established near Montreal by Sir William McDonald.

DR. J. F. POMPECKY, for the last ten years associated with the late Professor Karl von Zittel, at Munich, has been appointed professor of geology in the agricultural school of Hohenheim, near Stuttgart.

DR. KARL EXNER, professor of mathematical physics at Innsbrück, and Dr. A. Bauer, professor of chemistry at the Vienna Polytechnic Institute, have retired from active service.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 2, 1904.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND CONVOCATION WEEK.

THE permanent secretary of the American Association for the Advancement of Science has compiled an abstract of the communications printed in SCIENCE early in the year in regard to the meetings of the American Association and the special scientific societies, which is here printed, in order that further discussion may be elicited either in the columns of SCIENCE or at the approaching meeting of the association.

NICHOLS, E. L. (29 Jan., '04, No. 474, p. 192).

The plan of convocation week is a distinct step in advance. * * * The general feeling in the west seems to be for summer meetings; in the east for winter meetings. Many of us would be glad of a choice, with the privilege of attending either or both. Summer meetings should be held in some attractive and accessible resort; in mountains, on lakes or at the seashore. Select earliest possible date after closing of colleges and thus avoid the summer rush to these places. Bringing together of various affiliated societies at a common meeting place helps to mitigate one of the most unfortunate features of modern specialization in science—the separation of men of science into small groups. Question of expense of two meetings a year not worthy of consideration. It is imperative that the association afford those members who can not attend the winter meetings an opportunity for intercourse with kindred spirits at time and place possible to them.

W. LE CONTE STEVENS (29 Jan., '04, No. 474, pp. 192–4).

Gives his hearty approval to the editor's suggestions and views. Commends as well worth trying the plan (see editor's article) of each society sending accredited delegates to the annual meeting.

J. S. Kingsley (29 Jan., '04, No. 474, pp. 194–5).

It seems best that societies retain their independence and hold their meetings without regard to movements of larger organization. Might meet together where accommodations were adequate but such places would be few and far between. Separate societies have by right of preemption a claim upon Christmas holidays for their meetings.

Jas. Lewis Howe (5 Feb., '04, No. 475, pp. 228–230).

Each society should have its regular annual meeting in *summer* for presentation of papers, for excursions, for study or for whatever is of most value to the members as specialists. Meetings should be held without regard to those of any other society, as to either date or place. In winter should be held a *convocation week* meeting of all the scientific societies together with the American Association. No papers of restricted interest should be read; presidential addresses and lectures should be given and sectional discussions on topics of general *sectional* interest. No inconsiderable attention should be paid to social side of these meetings but each day should be properly apportioned. Advocates a federation to take place of existing organizations. Council to be made up of representatives chosen by the societies. Finances to be on same basis as at present. Addresses to be printed in Science and 'Proceedings' to be discontinued. Such a winter gathering should be held in a large and easily accessible center. To obviate difficulty of great distances separating workers hold general meeting biennially and divide country into several geographical sections with meetings in each on alternate years.

H. W. Wiley (5 Feb., '04, No. 475, pp. 230–231).

Advocates the solidifying of smaller societies into national societies which latter are to bear same relation to sections in the American Association for the Advancement of Science as the American Chemical Society does to Section C at present. Believes there is too great a tendency to organize separate and independent societies in each branch of investigation. Believes in American Medical Society affiliating with the American Association for the Advancement of Science. If all this could be accomplished we should more than quadruple the membership.

John M. Clarke (5 Feb., '04, No. 475, pp. 231–2).

Confesses to a 'feeling of apprehension at the insistent and impetuous efforts which are making toward the centralization of scientific endeavor in the United States and the creation of a formidable scientific machine in which individuality is to be reduced to a cog.'

"I am disposed to apprehend that centralization of science means the creation of a juggernaut which will crush endeavor, stupefy ambition, incinerate stimulus, minify personal achievement and cachinnate at honor."

O. T. Mason (5 Feb., '04, No. 475, pp. 232–233).

Take especial pains to have at annual and mass meetings men of distinction, of whom all have heard and whom they desire to see. Encourage specialization. Closest affiliation of specialists and aggregation into a mutually helpful cooperation are necessary to the intention of a science. It can not be too compact or too lively.

Simeon E. Baldwin (12 Feb., '04, No. 476, pp. 263–264).

I think the association meetings should be held when and where they will attract the largest attendance and sectional or affiliated society meetings so arranged as to make it easy for members to pass from one room to another and hear something on many subjects. Largest attendance, I believe, can be secured in *July* or *August*. Convocation week is not even a free week for all college and university professors, to school teachers seldom free, and to business and professional persons, rarely if ever free.

Theodore W. Richards (12 Feb., '04, No. 476, pp. 263–264).

A general meeting once a year ought to be

enough. Both midwinter and midsummer are likely to be unpleasant for travel in America, and therefore early autumn seems most feasible time, unless colleges could be induced to give a common spring vacation. Another argument against midwinter is that laboratory work is usually in best shape to show after winter-work is over and in the spring or autumn.

WILDER D. BANCROFT (12 Feb., '04, No. 476, pp. 264–265).

Improvement of meetings of sections necessary before men working in different fields can be brought together. Attendance at meetings largely from a sense of duty. Presiding officers too often overload the program and give no opportunity for discussion. Local members plan too many excursions for each afternoon. It is a waste of energy by committee and by visitors. Usefulness of the meeting lies in the personal element, in making men acquainted, in giving them a chance to discuss things and to exchange ideas. In morning have short papers; if possible of general interest, each paper followed by animated discussion. In afternoon men get together to talk over things more carefully, also for one excursion a day. In evening, general social gathering not confined to single sections.

CHAS. W. HARGITT (12 Feb., '04, No. 476, p. 265).

Must of necessity exist many technical societies, and there will be more rather than fewer. There then remains the 'imperative necessity for such organization of scientific effort as will make possible concentrated and consistent and direct sentiment for the enactment of needed measures of influence for whatever emergency may call for such.' Society of Naturalists did much of this class of work but it was too limited. Believes that the American Association for the Advancement of Science and in 'technical societies there are conditions and factors which properly correlated and adjusted, afford the most hopeful outlook for organized scientific progress within present generation.'

C. H. HITCHCOCK (12 Feb., '04, No. 476, p. 266).

Likes suggestion of two meetings and thinks localities might be chosen to fit the season; winter in the south, summer in the north or between east and west. With some affiliated societies, they could meet in the winter and put all their energies into work in the summer. The publication question is still open; if there were two annual meetings there could be two volumes printed, with some of the more important papers.

J. H. LONG (19 Feb., '04, No. 477, pp. 309–310).

Advocates the plan of *Section C* and the *American Chemical Society*. This will necessitate deciding upon and publishing places of meeting several years ahead. Suggests a committee from association, perhaps committee on policy, taking matter up and inviting cooperation from various societies. Thus a program for several years in advance can be prepared. *Convocation Week:* Not fair to draw conclusions from either the successful Washington or from the St. Louis meeting which was not so satisfactory. Personal preference for general meeting in June, just after commencement season. This is often too early for eastern schoolmen. September too late for college men and in August it is too hot.

MARCUS BENJAMIN (19 Feb., '04, No. 477, pp. 310–311).

What is needed is a consistent policy extending over a term of years in order that the advantages and disadvantages may be properly weighed. Council should be as nearly permanent as possible and changes limited to the new officers elected each year. The governing body should be changed only by a majority of its members.

JAMES E. RUSSELL (19 Feb., '04, No. 477, pp. 311–312).

Suggests that once in two years all meet in *same place* and on alternate years the affiliated groups serve their various interests. Much would be gained by returning biennially to the same place of meeting. It would tend to give the association a fixed home and a permanent and reliable constituency.

C. M. Woodward (19 Feb., '04, No. 477, p. 312).

Prefers special meeting at convocation week and the general association meeting ('scientific, technical and social') to be held in summer, either week before or after National Educational Association. Persons claiming membership in affiliated societies ought to pay something into association treasury or else their society pay for them.

Ernest Fox Nichols (26 Feb., '04, No. 478, p. 340).

Proposes two meetings: popular one in summer and a convocation week in winter which would thus serve as 'a clearing house' for the affiliated societies and the sections. Believes financial matters will interfere with two meetings.

E. H. S. Bailey (26 Feb., '04, No. 478, p. 341).

Convocation week meetings have proven satisfactory. * * * General meeting in late summer breaks in too much on vacations or seriously interrupts laboratory investigations or scientific excursions. Can be no valid objection to having semi-annual meetings of sections or of affiliated societies held during the summer months, but this should not interfere with attendance at the larger and more important *annual* meeting held in the winter at some central and convenient point.

T. C. Hopkins (26 Feb., '04, No. 478, pp. 341–342).

Proposes meetings of association sections in midsummer (not all sections at the same place) at such places as can be used to benefit that particular section by excursions, study or research. Sections could go to smaller places and thus enlarge scope of society and make many more adherents. Then have also the regular winter meetings.

Thomas H. MacBride (26 Feb., '04, No. 478, pp. 342–343).

Suggests for the botanists to maintain the section for botany in the association at all hazards and have but a single Botanical Society of America with at least two meetings a year, and always in connection with the American Association for the Advancement of Science. Let program of Section G consist of two parts; one of popular character held in forenoon of each day; the other to be purely professional.

Chas. S. Howe (4 Mch., '04, No. 479, p. 383).

Suggests appointment of representatives from each national society to meet at some central point this summer and thoroughly discuss the question in all of its bearings. Believes that Science might take the initiative and request societies to send representatives to such a meeting.

J. C. Branner (4 Mch., '04, No. 479, pp. 383–384).

States that 'those of us who live on the Pacific slope have some objections peculiarly our own.' Loss of time from Christmas vacation by rushing across continent and again at close of meetings recrossing. Trip is one of several thousand miles and requires from six to ten days. 3. Unable to obtain sufficient reduction in railway rates. 4. Loss of a few days that would be spent quietly at home. *Summer time* the meeting will only occupy part of the vacation period. However we fully realize that the question should be settled by the majority.

Ch. Wardell Stiles (4 Mch., '04, No. 479, pp. 384–385).

Let the present association be taken as a basis for national organization. Let present council be supplanted by a house of delegates, composed of representatives from each state society, number to be in proportion to the state membership; let all business affairs, questions of policy, etc., be transacted by this body. Let national association hold meetings convocation week and be divided into as many sections as necessary or desirable for purpose of presenting papers. *But* let it also be divided into state associations for purposes of representation.

C. Judson Herrick (4 Mch., '04, No. 479, pp. 385–386).

Believes that final adjustment will be "summer meeting of association with field excursions prominent, some of sections perhaps meeting in different places, and a convocation meeting in the winter devoted mainly to reading of technical papers, with a due proportion

of time devoted to public discussions and lectures on themes of general scientific interest and to social intercourse. Any attempt to force societies into summer months is foredoomed to failure."

CHAS. E. BESSEY (11 Mch., '04, No. 480, pp. 429–431).

Have one complaint about convocation week. It should come a week later or the state meetings a week earlier; they now interfere. Am inclined to accept Dr. Cattell's suggestion of a big winter meeting alternating with smaller and less formal summer meetings. Necessary to fix on places of meeting several years in advance and decide on general features of programs a year or so before the meetings.

GEO. F. ATKINSON (11 Mch., '04, No. 480, pp. 431–433).

Believes association is drifting from policy of keeping in close touch with general public and young students. Due to two causes or to one of the two: (1) To the change from summer to winter meetings; (2) to the tendency to discontinue former policy of extensive work and to desire to federate the different societies of the country. * * * *Time of Meeting:* Difficult unless Professor Nichols's suggestion is adopted and we hold both a summer and a winter meeting. Summer in the north and winter meeting in the south.

W. J. HOLLAND (11 Mch., '04, No. 480, pp. 433–434).

Idea of convocation week theoretically admirable but selection of time unfortunate. Christmas joys and festivals antedate the American Association for the Advancement of Science. Time of meeting should be in midsummer vacation.

W. F. GANONG (18 Mch., '04, No. 481, pp. 463–464).

Local sectional meetings should be held under auspices of *American Society of Naturalists.* A second group of societies desirable for (1) Vigorous but friendly rivalry will be distinctly advantageous and much preferable to a society monopoly. (2) American Association unlimited as to qualifications of membership and must always have and care for a large semi-scientific or popular element. That division of American Naturalists Society in which the American Association for the Advancement of Science meets should join with it in its meeting. Advocates strong national society for each of sciences, these to be divided into sections holding simultaneous meetings in geographical centers along with other scientific bodies affiliated with the American Society of Naturalists.

ARTHUR H. FORD (18 Mch., '04, No. 481, pp. 464–465).

Presents following plan to increase usefulness and influence: *Organization:* In addition to the present organization, establish a branch in each community where there are a number of members of the association. *Meetings:* In addition to the general meeting have each section meet once a year and each branch once a month, or oftener if profitable. *Publications:* Publish SCIENCE as at present, and in addition publish all papers presented at section meetings and the more important of those at branch meetings in the 'Transactions'; issuing a set of transactions for each section.

Best time for holding general meeting, at which social element should be emphasized, appears to be in early summer.

WILLIAM NORTH RICE (1 April, '04, No. 483, pp. 548–549).

Believes it is a mistake to change time of meeting from summer to winter. Inclemency of weather, inability to secure long vacation at this period, and love of home-life at this time are sufficient reasons. Believes it to be a good time for meeting of societies of restricted membership. Believes it to be a good plan to return to former arrangement.

ARTHUR HOLLICK (15 April, '04, No. 485, pp. 620–621).

Main province of association would seem, in future, to be that of organization and popularization of science. *Let summer meetings be continued* for purpose of arousing and maintaining popular interest and to serve as a common meeting ground for scientific and non-scientific men. Social element to be encouraged and get beginners and amateurs acquainted with older members. Open question whether winter meetings in addition are

advisable. Tendency to make these technical and it might be wise to encourage this idea. Let affiliated societies here take the leading position.

E. P. Felt (15 April, '04, No. 485, pp. 622–623).

Two general sessions of association ought to meet every demand at the meetings; one to mark the opening of the meeting, the other to give the president opportunity to deliver his address. Notices for each day could appear on program, thus allowing unbroken day. Morning meetings devoted to general papers. Afternoon meetings to special papers before subsections or societies. Evenings to sessions of members for short addresses on topics of general interest. We would favor the continuing of the complimentary lecture to the people of the city where the meeting is held. All evening meetings should close by 9:30, leaving time for banquets, etc.

W. J. Beal (20 Mch., '04, No. 490, pp. 797–798).

"Let association keep up all its sections, possibly adding to the number, freely cooperating with special societies, each section showing a willingness to unite in preparing a program with any one or more special societies having a like object." Years ago Professor Cope, Mr. W. A. Rogers and Mr. E. S. Morse objected to presentation of popular papers. I have recently thought it desirable to have a number of selected speakers present some topic or series of topics in a popular way to attract 'outsiders.'

3. "Education, economics, but not philology."

4. "Once a year, preferably in winter, till this date has had a fair trial."

5. "Meet most of time in populous regions from Washington to Boston, Detroit to Chicago, where many people are most sure to attend."

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*AN ANALYSIS OF THE PHENOMENA OF ORGANIC 'POLARITY.'**

The so-called 'polarity' that is shown in the regeneration of animals and plants has always been regarded as an expression of a fundamental influence of the old upon the new growth. By polarity is meant in a general way that from the anterior end of a piece of an animal a new head regenerates, and from the posterior end a new tail. Many exceptions to this rule have been discovered in recent years, and in the light of these discoveries, I think, we are now in a position to undertake a more thorough analysis of the phenomena of organic polarity than was possible without these new facts to guide us.

I shall group the main points to be discussed under four artificial headings: (1) 'Regeneration when *no* Alternative Exists at a cut Surface,' (2) 'Regeneration when an Alternative does Exist,' (3) 'Regeneration when the Relative Rate of Growth Depends on Preformed Elements (Buds)' and (4) 'Lateral Regeneration.'

1. REGENERATION WHEN NO ALTERNATIVE EXISTS AT A CUT SURFACE.

If the tail of a tadpole is cut off a new tail regenerates at the posterior end of the tadpole. The tail that is cut off does not ordinarily regenerate at its anterior end, *because* it dies before regeneration can take place. If it is kept alive, either by grafting or by remaining partially attached, it regenerates from its anterior end, *not* a tadpole, but another tail, reversed in direction. The conditions are such that both at the anterior and at the posterior cut surfaces only a tail can develop. The new tail from the posterior cut surface is in the direction of the old polarity, while that from the anterior cut surface is in a reverse direction.

In the earthworm a similar condition has been found. If the worm is cut in two at any level behind the gizzard, both cut ends regenerate a tail. Anterior to this level, however, the posterior piece regenerates a head on its anterior end. It is

* Read before the National Academy of Science, November 16, 1904.

not improbable that the anterior piece also, if kept alive, would regenerate a head on its posterior cut surface.

I have obtained a similar result with the leg of one of the salamanders, *Spelerpes ruber*. If the foot is first cut off and then the skin of the foreleg is loosened, so that a piece of the internal parts can be cut out, and if this piece is turned round, and grafted in the pocket made by the loosened skin, there regenerates from the free end a new foot (and not a salamander).

A few other examples might be given, but these will suffice to illustrate the main points. The new part has in these cases only one possibility, and the same structure regenerates from the anterior and from the posterior cut surface, regardless of the 'polarity' of the old part.

The interpretation of these facts is, I believe, not difficult in the light of certain other results that are now known. Only one kind of structure develops because the group of new cells that appears over the cut end is such that out of it only one kind of organ can be formed. This may sound paradoxical, but my meaning will, I hope, be clearer when we have considered the next category, when an alternative exists.

2. REGENERATION WHEN AN ALTERNATIVE EXISTS.

The worm *Lumbriculus* furnishes the most striking instance of this sort. If the worm is cut in two *at almost any level* a head regenerates from the anterior end and a tail from the posterior end. Since the two cut ends are identical, each must have both potentialities. Nevertheless, a head forms at one end and a tail at the other. Planarians give the same results. Pieces of *Hydra* also behave in the same way. Another hydroid, *Tubularia*, often produces a head (hydranth) at one (apical) end and a stolon at the other; but also quite frequently produces a head at both ends. It has been shown, in fact, in all these forms, except *Lumbriculus*, that a head may regenerate on the posterior end under certain conditions.

Thus, if the apical end of *Tubularia* be tied or stuck into the sand, a head develops on the basal end. If a piece is sharply bent the same result happens.

If very short cross-pieces of *Planaria maculata* be cut out, a head often develops on both ends. If two pieces of hydra are grafted together by their anterior ends, one piece being longer than the other, the 'polarity' of the shorter piece will be reversed, and a single hydra regenerate.

Several recent writers have attempted to account for these cases of reversal on the old Bonnet-Sachs hypothesis that formative stuffs migrate in definite directions. Loeb, for example, has tried in a recent paper on *Tubularia* to rehabilitate this view, but, I believe, without success. During the past summer I have carried out a large number of experiments on *Tubularia*,* which I think show that the assumption of the migration of stuffs in definite directions is not needed to explain the results, and there is in reality nothing in the experiments to support such an idea.

It would take me too long to go into the details necessary to substantiate this statement; but in a forthcoming paper I shall hope to discuss the question more fully. It must suffice here to state that, in my opinion, the development of a head on the apical or on the basal end of *Tubularia* may be explained if we assume that the amount of nutritive substances present at a given moment represents one of the internal factors and the stimulus of the sea water on the *more responsive* free end (which is always that nearer to the old head) represents the external factor that calls forth the regeneration of the hydranths.

The third category applies only to plants.

* In collaboration with N. M. Stevens.

3. REGENERATION WHEN THE RELATIVE RATE OF GROWTH DEPENDS ON PREFORMED ELEMENTS.

If a piéce of a willow be cut off and suspended in a moist atmosphere the apical buds produce new shoots (the basal buds hardly developing at all). Roots develop around the basal end of the piece from preformed root-buds. This phenomenon is so similar to what takes place in the regeneration of animals that the same term, 'polarity,' has been applied here also. Now I believe it can be shown that the phenomenon is not the same in the two groups and is the outcome of quite different factors. An examination of the results in plants will show that the first buds to develop are the most vigorous ones, which are usually the largest. In the case of the willow the largest buds are those nearer, although not at, the distal ends of the branches. If these buds once begin to develop they will use up the available food stuffs in the piece, and thus hold in check the development of the more basal buds. Hence the latter fail to develop. In some other plants the basal buds are the most vigorous ones and these develop first. Whether the same explanation will account for the root development can not be stated, because, so far as I can discover, no one has shown whether the root-buds nearer the base are more advanced than are those nearer the apex. If this should prove to be the case the explanation used for the shoots will also account for the development of the roots. These phenomena in the pieces of plants led Sachs to apply his stuff hypothesis to explain them. He not only assumed that formative stuffs are present, but also that they move, in response to gravity, in definite directions. His latter assumption was shown to be untenable by Vöchting. A number of recent investigators still continue, nevertheless, to make use of Sachs's hypothesis in one form or another. Goebel, for instance, intimates that the 'polarization' of the tissues themselves is the cause of some of the formative (or, in some cases, nutritive) stuffs moving in one direction and of others in the opposite direction. Thus, while Sachs started out to explain polarity as the result of fluids flowing in a given direction, Goebel, nominally using Sachs's view, assumes the polarity in order to make the substances flow in predestined paths.

I think we need assume neither formative suffs nor their movements in specific directions. I have stated above that we can account for the results by means of a simpler and, I believe, a more reasonable explanation.

4. LATERAL REGENERATION.

If we confine our attention to the regeneration of the head and of the tail alone we get a very incomplete conception of the phenomena that are to be included under the term polarity, for animals regenerate not only in the directions of the poles of a magnet, but laterally, dorsally, ventrally. In short, in all three dimensions of space, or combinations of them. One example of many that might be given will illustrate my point.

If a planarian is split lengthwise into two equal parts, each half regenerates laterally its missing part. If we examine carefully the method by which this takes place we find that a narrow edge of new material appears along the cut side and in this material the new structures are laid down. The chief point of interest here is that the lateral organs develop long before the new part has reached the size of the part removed. Furthermore, at the outer, new edge the distal ends of the branches of the digestive tract are produced, and along the line between the new and the old material the median organs are laid down. The intermediate parts

are at first much shortened, perhaps even undeveloped. Thus there is no building outwards of the new organs from the cut edge, but, on the contrary, the differentiation is in large part centripetal in direction. Pflüger thought that the regeneration of a new part may take place in somewhat the same way that a crystal grows in a saturated solution, but the case that I have just given shows that this conception will not explain the main facts,* although it is not to be denied that to a limited extent the old organs along the cut edge may have some influence on the formation of the new organs besides that of proliferating new cells.

The same points that are illustrated by the last case are even more strikingly shown in a piece cut off far out to one side. In this case the structures exposed along the cut edge are not median structures, yet the new median organs are here also laid down between the old and the new tissues. The old parts in this case can not be supposed to determine the formation of the median organs, as was possible in the former instance, but the entire process of differentiation in the new material is rather centripetal, *i. e.*, from the surface inwards. At least, if the actual differentiation is not in point of time from without inwards, the influences that determine the extent and kind of organs that are laid down must be thought of as acting in this way.

In these pieces that regenerate laterally a new head appears at the anterior end of the new material and a new tail at the posterior end. The position of the pharynx in lateral pieces removed from different levels of the body gives a clue to one, at least, of the internal factors that must be at work. If the lateral piece is from the anterior region of the worm, the new pharynx develops near its posterior end; if the piece is from the middle of the worm the new pharynx develops near the middle; and if the piece is from the posterior region the new pharynx develops near the anterior end. Thus the location of the pharynx gives us a clue to certain conditions present in the new part. An analysis of the results leads to the following conclusions:

1. The new material is at every level totipotent, as shown by the fact that a new head will form near the anterior end of a piece at whatever level the piece has been removed.

2. The new material although totipotent is not homogeneous, or, more technically, not isotropic, as shown, for example, by the position of the pharynx. We must conclude from this that the material is somewhat different at every level, and that this difference corresponds *in kind* to the character of the body at each level. Consequently there is in every piece a gradation in the new material from before backwards that gives us the phenomenon that we call polarity. With this difference, or polarity, as a basis the centripetal influence, acting from the surface inwards, determines the organization of the new part.* The action of this centripetal influence is on the new part as a whole, and determines the relative location of each organ.

By means of these three assumptions—of totipotence, of heterotropy and of organization-power—we can explain the main features in the result. Each assumption is, moreover, a direct deduction from an experiment or observation![†]

This view will also account for the de-

* Pflüger's view does not explain those cases in the regeneration of a head or tail when the new part is shorter than the part removed.

* This idea of the action from without inwards was formulated by Morgan in 1899, and by Driesch more fully in 1900.

† The same explanation applies to the development of the egg.

velopment of a head at the anterior end and a tail at the posterior end of a cross piece of planaria, or of lumbriculus, or of hydra. In the planarians a head forms on the anterior end, because, on my view, the new material there is continuous with the new material throughout the old part and the difference in the character of the parts at each level gives the basis on which the organizing power acts. Similarly for the tail development at the posterior end. In *Lumbriculus* the same conditions hold. In both cases the old tissue may be so little differentiated that its regional differences may also furnish the basis for the organizing power to act. *Very short cross-pieces of Planaria maculata* often produce a head at each end. This result may be due, as I have explained elsewhere,* to the absence of sufficient difference between the ends on which as a basis the organization of the posterior end can take place. It must be assumed in this case that the external and internal factors, in the new part, have a stronger influence in calling forth a new head than a new tail—much as in *Tubularia*. In hydra no new tissue is produced at the cut ends, but the old part molds itself into the typical form. Here the old tissues are so little fixed that the organizing power acting along the lines of regional difference molds the old part into a new whole. In this respect the difference between hydra and the other forms is merely relative.

My view differs in many points from the stuff hypothesis. It assumes no specific stuff apart from the living material, and consequently it makes no assumption of the migration of such stuffs in multicellular organisms;† it assumes that the material at each level has in addition to its totipotence something also of the material basis characteristic of that level. Lastly, my view takes into account the organizing power of the living material which builds up its structure independently of cell boundaries on the basis of the totipotence and heterotropy of the new part. It is needless to point out further differences of minor importance.

Another example of lateral regeneration brings into the foreground the character of the organizing factors that are at work. If the arm of a salamander is cut off near the body new material appears over the cut end, and while the new material is still relatively small in amount (compared with the amount removed) a new limb, including parts of all the structures, is laid down. The humerus does not complete itself, and then the other parts form in order of succession from within outwards, but simultaneously the new material is proportionally subdivided or *segregated* into the typical elements. Subsequently the new parts all grow larger and longer, until the new limb reaches the size of the one on the other side.

The migration hypothesis is not needed in this case where no alternative exists to account for the location of the new part, and it is helpless to explain the phenomenon of segregation that takes place when the dif-

* 'The Control of Heteromorphosis in *Planaria maculata*,' *Roux's Archiv*, XVII., 04.

† It has been shown in the case of the egg of many forms (frog, sea-urchin, crepidula, ascidian) that movements of the protoplasm may occur. The differentiation that results appears to follow, to some extent at least, the regional differences in the protoplasm. Here we are not dealing with formative stuffs, in the original sense of the term, but with differences in the kinds of protoplasm, or perhaps only with quantitative differences, which become relegated to different cells. It is presumably the same differences of protoplasm in the cells of the fully formed animal that furnishes the basis for the regional differences in the new and old material in antero-posterior regeneration, etc., and which gives the basis on which the organizing changes go forward. In multicellular forms there is no extensive evidence of migration from cell to cell of the different kinds of protoplasmic materials, nor any necessity of making the assumption that they do migrate.

ferentiation occurs. In my view the material of the new stump is at first totipotent (at least for each kind of material); the surface and the ends of the old organs are the terminals between which the segregation of the new parts takes place.

Let us next turn our attention for a moment to the factors that determine the organization of the new structure.

The term *formative force* was formerly used to cover the changes that take place when the new organ 'crystallizes,' as it were, in the new material. Since no such force is known in the physical world, modern biologists have looked askance at the term. In one sense they are, of course, entirely justified in doing so, because no such creating force is known to us outside of the phenomena to be explained, and the term, therefore, only restates the changes and can not be used as a causal explanation of them. In another sense, however, the use of this term may come nearer to an expression of what is needed than any attempt to explain the results by known chemical or physical 'forces' or energies or principles; for it seems to me that we are dealing here with a phenomenon characteristic of living material—a phenomenon that is unknown to the physicist. This does not mean that I believe the phenomenon is not capable of a causal, *i. e.*, of a physical, explanation. In fact, I have every reason to believe it belongs to this category, but it is not a principle that the physicist meets with, or, at least, has yet met with outside of living material—unless, indeed, the so-called liquid crystals of Lehmann represent a similar phenomenon.

The term *'formative force'* is obnoxious also because of the dubious use of the word *force*. It has been pointed out that since no two animals develop in the same way, or regenerate identical structures, there would be as many kinds of formative forces as there are animals that develop or regenerate. In fact, there would be in *each* animal as many kinds of formative forces as there are *parts* that can regenerate. I believe the objection is well founded, at least, to the extent that it shows that we are not offering a causal explanation when we refer the phenomena to a formative force. On the other hand, no one knowing the facts can doubt that all the cases belong to the same general category; but since the composition of no two animals belonging to different species is the same we should not expect the egg or the newly formed materials to organize themselves in exactly the same way, although the *kind* of action may be the same in all of them.

We meet with the same problem in attempting to explain certain facts in inorganic nature. The salts of different substances crystallize each in its own peculiar way. It would, therefore, be just as misleading to speak of a *crystallizing force* as of a *formative force,* yet no one doubts that the crystallization of each salt depends on some property that all salts have in common.

We meet here with a philosophical principle that it would be out of place to discuss at this time, yet it is a point of as much importance to the practical, thinking experimentalist as to the theorist. I suggest that, for want of a better term, we may provisionally call the property of living material to assume a specific form the property of *formative organization.*

I may sum up my conclusions categorically as follows:

1. Where no alternative exists at a cut surface there is no question of polarity and we have simply to deal with the phenomenon of formative organization, which I would suggest, but can not prove, is in some way a phenomenon of contraction depending on the relative condition of tension in the parts.

2. When an alternative exists at the cut end we meet with the problem of polarity also. In the hydroid, *Tubularia*, an analysis of the conditions leads me to conclude: (1) That the hypothesis of stuffs moving in given directions does not explain the facts, (2) that the results can be accounted for on the ground of the amount of nutritive substance present in the pieces, taken in connection with the relative conditions of the stem at each level. Furthermore, in this case the stimulus of the water on the exposed end, calling forth hydranth regeneration, is an important factor in the result.

3. There is nothing in the phenomena to suggest that the old part has a stereometric influence, *i. e.*, a directive influence on the new part, as the term 'polarity' suggests. On the contrary, the influence is largely centripetal in direction, so far as there is any question of direction involved.

4. An analysis of the conditions present in lateral regeneration in planarians suggests that at least three separate factors are to be recognized in the changes that take place. I have put these factors into the categories of (*a*) totipotence, (*b*) heterotropy and (*c*) organization.

5. The ends of the old organs have also an influence on the regeneration, but a less important one in some cases than those just mentioned.

6. The same factors are also present in antero-posterior regeneration in which an alternative is present. When *no* alternative exists the totipotence has certain limitations, which depends, however, on the special combination of tissues in the new part, rather than on any limitations in each group of cells.

7. The organizing principle acts on the new and old part *as a whole* and determines the relative arrangement and proportions of the new organs.

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*MOSAIC DEVELOPMENT IN THE ANNELID EGG.**

Our general interpretation of the problem of development has been somewhat prejudiced by the fact that so much of the earlier experimental work dealt with such eggs as those of echinoderms, medusæ, *Amphioxus* or the nemertines, where any one of the first two or four cells may produce a perfect dwarf embryo; for such cases seem at first sight to be irreconcilably opposed to any theory of definite pre-localization or mosaic development. The collapse of the Roux-Weismann theory of differentiation by qualitative nuclear division discredited for a time the whole mosaic theory; but more recent experimental work, especially on the eggs of ctenophores and mollusks, promises to re-establish it on a new basis. In the course of the past year I have been able to show experimentally that the development of mollusks (*Dentalium, Patella*) conforms in its main features to the mosaic principle, and, furthermore, that the cleavage mosaic is foreshadowed by a very definite original pre-localization of specific protoplasmic materials in the undivided egg. During the past summer I have had an opportunity to extend these observations in some measure to the egg of an annelid, where the same general principle has been found to hold true.

The development of the annelids presents the problem in a very clear-cut form, since from the first cleavage onward the principal material of the segmented trunk-region lies in the posterior cell of the embryo, and this cell is in most species somewhat larger than the anterior, and hence may be immediately identified. The experiments here reported consist in a comparison of the development of the isolated posterior cell of the two-cell stage with

* Read before the National Academy of Sciences, November 16, 1904.

that of the isolated anterior cell, especially in the genus *Lanice*, which I have found the most favorable egg for operation of all the many forms tested. While the number of successful operations has been rather small, they have given a very definite result, and one that is in its main features in agreement with the one earlier obtained in the eggs of the mollusk *Dentalium*. When either cell of the two-cell stage is destroyed, the remaining cell segments as if it still formed a part of an entire embryo. The later development of the two cells differs in an essential respect, and in accordance with what we should expect from a study of the normal development. The posterior cell develops into a segmented larva with a prototroch, an asymmetrical pre-trochal or head region, and a nearly typical metameric seta-bearing trunk region, the active movements of which show that the muscles are normally developed. The pre-trochal or head-region bears an apical organ, but is more or less asymmetrical, and, in every case observed, but a single eye was present, whereas the normal larva has two symmetrically placed eyes. The development of the anterior cell contrasts sharply with that of the posterior. This embryo likewise produces a prototroch and a pre-trochal region, with an apical organ, but produces no post-trochal region, develops no trunk or setæ, and does not become metameric. Except for the presence of an apical organ, these anterior embryos are similar in their general features to the corresponding ones obtained in *Dentalium*. None of the individuals observed developed a definite eye, though one of them bore a somewhat vague pigment spot.

This result shows that from the beginning of development the material for the trunk region is mainly localized in the posterior cell; and, furthermore, that this material is essential for the development of the metameric structure. The development of this animal is, therefore, to this extent at least, a mosaic-work from the first cleavage onward—a result that is exactly parallel to that which I earlier reached in *Dentalium*, where I was able to show that the posterior cell contains the material for the mesoblast, the foot and the shell; while the anterior cell lacks this material. I did not succeed in determining whether, as in *Dentalium*, this early localization in *Lanice* preexists in the unsegmented egg. The fact that the larva from the posterior cell develops but a single eye suggests the possibility that each of the first two cells may be already specified for the formation of one eye; but this interpretation remains doubtful from the fact that the larva from the anterior cell did not, in the five or six cases observed, produce any eye. This subject remains for further examination, which I hope to be able to carry out hereafter.

These observations, in connection with my preceding ones on the molluscan egg, contribute to the growing body of evidence that the development both of annelids and of mollusks is to be regarded as a mosaic-work of self-differentiating cells; and, further, that the specific morphogenic factors are connected in some way with specific forms of protoplasm, which I think may conveniently be designated as formative (perhaps better, 'morphoplasmic') stuffs. I have endeavored in two recently published papers to show that the same principle applies to the eggs of other animals, even in such cases as the sea-urchins or *Amphioxus*, where either of the first two cells may produce a complete embryo. The explanation of the difference between the two cases appears to be that in the mollusk or annelid the cytoplasmic stuffs undergo an asymmetrical distribution during the first division, while in the sea-urchin or *Amphioxus* the distribution is symmetrical. The division is, therefore, in the first case

qualitative, in the second case quantitative only, thus giving the immediate possibility of the production of two embryos from a single egg. It appears to me that we find here a principle of reconciliation between the hypothesis of mosaic development and pre-localization, and the apparently contradictory one of non-mosaic or correlative differentiation. The facts show that each of these apparently contradictory hypotheses contains an element of truth; that we must recognize in the development of every animal the fact of pre-localization and of mosaic development, but also the fact of correlative action. The relation between these two can not be predicted, but must be determined in each individual case; for the known facts are already sufficient to prove that the segregation of the formative stuffs is a process that occurs at different periods in different animals. At the time of fertilization, accordingly, the segregation differs both in degree and in form; and these differences have not yet been reduced to any general law.

In conclusion, I would express the opinion that, so far as the early stages of development are concerned, it is difficult to escape the hypothesis of formative stuffs or specific morphoplasmic substances, in some form. But while this hypothesis facilitates an understanding of the *modus operandi* or immediate causes of differentiation, it leaves us as much as ever in the dark as to the localizing or form-determining factors which are responsible for the determination of the segregation pattern. This problem, which is essentially one of correlative action, is not only unsolved, but suggests the existence of specific energies for which it is difficult at present to find an analogy outside the field of protoplasmic action.

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SCIENTIFIC BOOKS.

Contributions to the Study of the Behavior of Lower Organisms. By Herbert S. Jennings. Published by the Carnegie Institution of Washington. 1904. 256 pp., 81 text-figures.

In the series of papers which make up this volume Professor Jennings presents results which are of fundamental importance for our understanding of the behavior of lower organisms. The titles of the seven papers of the volume are as follows: (1) 'Reactions to Heat and Cold in the Ciliate Infusoria,' (2) 'Reactions to Light in Ciliates and Flagellates,' (3) 'Reactions to Stimuli in Certain Rotifera,' (4) 'The Theory of Tropisms,' (5) 'Physiological States as Determining Factors in the Behavior of Lower Organisms,' (6) 'The Movements and Reactions of Amœba,' (7) 'The Method of Trial and Error in the Behavior of Lower Organisms.'

For the purposes of this review the papers may be separated into three groups. Of these the first, which includes the first three papers, is devoted primarily to descriptions of the modes of reaction of several of the lower organisms, and to a discussion of the bearing of these reactions upon the 'orientation theories' of Loeb and Verworn. The second group is constituted by the paper on Amœba; in it the author deals in detail, as a result of his own observation, with the mechanics of locomotion, modes of reaction and psycho-physiology of the organism. Papers four, five and seven are included in the third group. In addition to presenting several points of interpretation, they contain discussions of the relations of the author's results to the general theory of tropisms.

I shall now attempt to state briefly the principal points made in each of these three subject divisions of the volume.

In explanation of the directive influence of stimuli on the movements of various organisms Loeb, Verworn and others have proposed the so-called orientation theories.

According to these theories a stimulus which acts unequally upon different portions of the body causes inequality of contraction in the musculature, and thus brings about a turning

of the body either toward or away from the source of stimulation. The animal is perfectly oriented with reference to the stimulus when symmetrical points on the body are equally stimulated.

By careful observation of the behavior of several types of lower organism Jennings has determined to his own satisfaction, and judging from the nature of his descriptions with certainty, that the reactions of the unicellular organisms, and also those of some of the metazoa, are not in harmony with the current theories of orientation. The reaction of ciliate infusoria to heat and cold is thus described, in summary, by the author, "the response, on coming into a region where the temperature is above or below the optimum, is by backing and turning toward a structurally defined side, followed by a movement forward. This reaction is repeated as long as an effective supraoptimal or suboptimal temperature continues. The result is to prevent the organisms from entering regions of marked supraoptimal or suboptimal temperature, and to cause them to form collections in regions of optimal temperature. The common orientation of a large number of individuals sometimes produced in this way is an indirect result of the method of reaction. Since movement in any other direction than a certain one is stopped, the organisms after many trials come into this direction. Orientation is, therefore, by 'exclusion,' or by the method of trial and error" (p. 28).

Similarly the author has shown that the reactions of ciliates and flagellates to light are not in accordance with the assumptions of the theories of orientation.

Among the multicellular organisms the Rotifera, according to the observation of Jennings, turn as a rule toward a structurally defined side—the dorsal—without relation to the side stimulated most strongly, and continue turning, or alternately turning and darting forward, until the anterior end of the body is directed away from the source of stimulation. "Thus the direction of turning is throughout dependent upon an internal factor, not primarily on the way in which the stimulus impinges on the organism. These reactions of the Rotifera are thus inconsistent with a theory of tropisms which regards orientation as a primary feature of the reactions, and which holds that the action of the stimulating agent is a direct one on the motor organs of that part of the body on which it impinges" (p. 88).

Of the correctness of Jennings's observations there can be little doubt, for all his work is characterized by admirable care in observation and accuracy in description, but in criticism of the manner in which he discusses the bearing of his own results upon the orientation theories it might be said that he does not make sufficient allowance for the asymmetry of the organisms with which he worked. The fact that the various unicellular organisms and rotifers whose behavior is described in these papers do not orient according to the theories of Verworn or Loeb by no means proves that their theories are in principle wrong. Jennings's work does, however, very emphatically call attention to certain weaknesses and false assumptions of the theories in question, for their advocates have too often adduced the presumably well-known reactions of these very organisms in support of one or another form of the theory of the tropisms.

It is only fair to the author to state that his arguments are directed more especially against the 'direct action' assumption of the tropism theory than against the theory of orientation. He believes that his observations prove beyond a doubt, for the animals studied, that stimuli bring about reactions by their general action upon the organism rather than by direct local action, and he, therefore, contends with good reason that the theory of the tropisms as stated by Verworn, Loeb and others is radically wrong.

It is worthy of note, in connection with the facts of Jennings's studies, that the turning toward a structurally defined side which is so common among the unicellular organisms serves usually, although not always, to direct the organism away from the source of stimulation. For example, *Paramecium* turns towards its aboral side, hence away from the currents of stimulating substance which are drawn

toward the oral region by the ciliary movements. The same conditions obtain in the Rotifera, for there the ciliary current passes to the mouth, on the ventral side, and the organism, in case the current carries a stimulating substance, turns toward the dorsal surface.

Turning our attention now to the second subject-group, we find that Jennings undertook the study of the behavior of Amœba with two definite purposes in mind: (1) To determine how far recent physical theories explain the activities of the organism, and (2) to add to, systematize and unify our knowledge of the subject.

Fortunately the author did not confine himself to the unexplored regions of his field of research, but instead repeated the experiments and attempted to verify or replace the so-called facts of other investigators, and test their theories.

The results of this thorough reinvestigation of the subject are in many respects startling. In the first place, Jennings finds that the descriptions of the protoplasmic currents within the moving Amœba given by Bütschli and Rhumbler are not true to the facts. These investigators have stated that there is a forward-moving axial current and a backward-moving surface current at the sides of the animal, the conditions in the organism being practically the same as that in a drop of inorganic substance whose surface tension is decreased at some point. Jennings has been able to demonstrate to his entire satisfaction by the use of several simple methods that there is only a forward current. As this is an important matter we may appeal to his excellent description of the observations. "In an advancing Amœba substance flows forward on the upper surface, rolls over at the anterior edge, coming in contact with the substratum, then remains quiet until the body of the Amœba has passed over it. It then moves upward at the posterior end, and forward again on the upper surface, continuing in rotation as long as the Amœba continues to progress. The motion of the upper surface is congruent with that of the endosarc, the two forming a single stream" (p. 148).

This is of special interest because it sweeps away one of the principal supports of the surface-tension explanation of the movements of Amœba. And it may well be added here that Jennings's methods are so much superior to those employed by many of the earlier investigators, and his observations so much more detailed, that his results will almost undoubtedly be verified by others shortly.

After a minute study of the formation of pseudopodia, the reactions to stimuli, food-taking, and several other interesting features of the behavior of the organism, the author formulates the following general conclusions with respect to the mechanism of movement: "Altogether, then, our results lead us to look upon Amœba as an elastic and contractile sac, containing fluid. In locomotion one side of this sac actively stretches out, becomes attached to the substratum, and draws the remainder of the sac after it in a rolling movement. The primary phenomena are the stretching of one side, the elasticity, and the contractility of the outer layer" (p. 172). The author does not attempt to account for the pushing out of the anterior edge, nor does he theorize concerning the nature of the contractility of the ectosarc.

Perhaps the most important general results of the study, so far as the views of the author are concerned, is that it shows pretty conclusively that we have not thus far succeeded in analyzing, as Bütschli, Rhumbler and others appear to think they have done, the behavior of any organism to the point of complete physical explanation. After all the external factors have been taken into account there appears still to be a necessary factor or complex of factors which have to be referred to the organism itself. External physical factors apparently suffice for the description of certain of the activities of the lower organisms as well as of the higher; but usually critical research shows that the descriptions are not complete. As Jennings remarks, 'Putting all our results together, we must conclude that the movements and reaction of Amœba have as yet by no means been resolved into their physical components' (p. 225).

In the third group of papers the author

brings out forcibly the fact that almost every reaction of an animal involves or is conditioned by the activity of the total organism. The tropism theory is misleading in so far as it seems to suggest that local action, largely independent of the conditions of the body as a whole, is the common rather than the exceptional determinant of reaction. In this portion of the volume it is evident that Jennings is emphasizing the unknown factors in animal behavior, while at the same time severely criticizing those observers and theorists who contend that they can reduce organic activity to physical factors.

Trial and error is the method of adaptive reaction which is most frequently observed in the lower organisms. In a discussion of this topic the author is drawn into a discussion of the meaning of 'error': "There is no common thread running through all the different agents which constitute 'error' in the reaction, save this one, that they *are* error from the standpoint of the general interests of the organism. * * * Why do we receive without opposition certain chemical stimuli and avoid others? The facts are quite parallel in man and in the lowest organisms in these respects. * * * In both cases the stimuli producing the negative reaction are in general injurious to the organism (p. 247).

"In ourselves the stimuli which induce the negative reaction bring about the subjective state known as *pain*, and popularly we consider that the drawing back is due to pain. Is there ground for this view? Or is the reaction entirely accounted for by the chemical and physical processes involved? * * * If we hold that in man we can not account for the reaction without taking into consideration the pain, then we must hold to the same view for the lower organisms. * * * Any one who holds that we can account fully for the reactions of *Euglena* or *Paramecium*, purely from the physico-chemical conditions, without taking into account any states of consciousness, must logically hold that we can do the same in man. The method of trial and error implies some way of distinguishing error; the problem is: How is this done? The problem is one, so far as objective evidence goes, throughout the animal series" (p. 248).

The criticism of this volume, as of many of Professor Jennings's other writings, that one is first inclined to make is that there is needless repetition, that the same simple facts are described and redescribed until one almost feels it an insult to intelligence. But this is a judgment which the author has passed upon himself, for he has elsewhere stated that he describes all his observations in almost painful detail in order that investigators who have cause to use his results may not have the disagreeable experience, that has been his often, of failing to find in the description of experiments some little point that is important for the problem in hand. Apart from its repetitions, the volume is well written; it is also well printed.

As to the content of the work, it may be repeated that the evidences of thoroughness, accuracy, fairness to other investigators, freedom from overhasty generalizing, are such as to inspire great confidence in the results, and to warrant one in believing that they will serve to advance our knowledge of the general subject of animal behavior in a very important manner. In fact, it is not at all improbable that they may necessitate important modifications in the tropism theory.

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RECENT BOOKS ON ECONOMIC AND SOCIAL SCIENCE.

Principles of Economics, with applications to Practical Problems. By FRANK A. FETTER, Ph.D. New York, The Century Co. 1904.

The United States and Porto Rico, with Special Reference to the Problems Arising out of our Contact with the Spanish-American Civilization. By L. S. ROWE, Ph.D. New York, Longmans, Green & Co. 1904.

Problems of the Present South. By EDGAR GARDNER MURPHY. New York, The Macmillan Company. 1904.

Russia, Her Strength and Weakness, A Study of the Present Conditions of the Russian Empire, with an Analysis of the Resources and a Forecast of its Future. By WOLF VON SCHIERBRAND, Ph.D. New York, G. P. Putnam's Sons. 1904.

America, Asia and the Pacific, with Special Reference to the Russo-Japanese War and its Results. By Wolf von Schierbrand, Ph.D., with thirteen maps. New York, Henry Holt & Co. 1904.

Greater America. By A. K. Colquhoun, F.R.G.S. With Maps and Diagrams. New York, Harper and Brothers. 1904.

Dr. Fetter's 'Principles of Economics' will rank high as a text-book. In technical equipment and class-room experience few men are better fitted than he. The most valuable parts of the book to the student of theory are to be found in those chapters in which he has recast many of the conclusions of economic thought, based on a much wider scope of generalization than is usually credited to earlier writers on economic principles. There is also a larger blending of the historical with the scientific method of treatment; the author has, therefore, been able to work out the various theories far more in harmony with facts than many of his predecessors have done. He has also shown the effect of statistical material upon the statement of principles. On the whole, his hope has been realized—'to further sound economic reasoning and to extend among American citizens a better understanding of the economic problems set for this generation to solve.' There are some parts of the volume, however, which, like the early words of the foregoing quotation, leave one in doubt as to just what is meant.

Dr. Fetter treats the subject from a standpoint of the study of values, as constituting the core of economic science. Values, according to his view, have an objective as well as a subjective aspect, and his classification is divided into three main heads: Values of material things, of human services, and social aspects of values, under each of which are a series of subheads, as indicated by the following outline:

I. Value of material things: Wants and present goods, wealth and rent, capitalization and time-value.

II. Value of human services: Labor and wages, enterprise and profits.

III. Social aspects of value: Relation of private income to social welfare, relation of the state to industry.

The measure of success is highly encouraging in the effort to apply principles to the discussion of problems. The questions and critical notes add materially to the value of the volume, showing that the author has fully appreciated the position of the student.

From the standpoint of scientific method less can be said. There is much more to be done before economic science, in the United States especially, shall have shifted its center of gravity from theoretical speculation to strictly scientific research. At the present time there is a great deal of restlessness at the barrenness of economic science, largely due to the too general prevalence of the speculative methods of treatment.

Economists, as a rule, have not felt called upon to be scientists; they have more often played the rôle of speculative inquirers, of economic philosophers—of privileged thinkers in a field over which their authority has gained in proportion to their regard for facts, rather than for theories applied to conditions which no longer exist, or which exist in no such degree as the theories imply. Thus it happens that chemistry, technology, geology and other sciences of economic content have gradually undermined popular confidence in economists. In many cases the engineer, for example, is more of an economist than the most orthodox professor of economics, because *his* judgment, and not that of the economist proper, has guided economic development.

'The United States and Porto Rico,' by Professor L. S. Rowe, of the political science faculty, University of Pennsylvania, and lately of the Porto Rican Code Commission, deals more generally with the political aspects of American influence in the West Indies. His volume has special reference to the problems arising out of our contact with Spanish-American civilization. While it is true that he looks at the subject chiefly from the legal standpoint, he has brought into order clear recognition of the social and economic conditions which have dominated government. The author shares the national hopefulness, as expressed in the final paragraph:

Whether we view the progress of the island from an industrial, political or social standpoint, the conditions are singularly favorable for the successful solution of the new problems presented by our Spanish-American possession in the Caribbean. The lessons that we are learning will be of service to us in the larger tasks that are before us. Future generations will look upon the experience acquired in the administration of civil affairs in Porto Rico as a period of training and preparation for the problems involved in our relations with the Spanish-speaking peoples of the American continent.

The chapter on 'The People' is most instructive. Of the population two fifths are colored, the island having a larger proportion of whites than most of the southern states. Three fifths of the people are engaged in agriculture, and the average *area per farm* is 45 acres compared with 146.2 acres in continental United States. Illiterates constitute 22.7 per cent. of the population, excluding all under ten years. An educational test, if applied to suffrage, would have excluded 76 per cent. of the males. The island's revenue is $2,500,000 (1903). Of the total income, local and insular, 28 per cent., or over one fourth, is applied to public education—an unusually large proportion, probably larger than that of any other community.

'Problems of the Present South, or a Discussion of Certain of the Educational, Industrial and Political Issues in the Southern States,' by Edgar Gardner Murphy, of Montgomery, Alabama, is a statement of the *rationale* of the southern policy in relation to the great pivotal questions of modern society, such as democracy, education, nationalism, industrialism, culture and the race question. Mr. Murphy succeeds well in his task. He has done good service in bringing thoughtful people back to the idea that the south is not attempting to solve its great social problems in a way which is out of line with national aspiration.

The chapters on the 'Schools and the People' and 'Constructive Statesmanship,' as well as that on 'Culture and Democracy,' must convince the reader that here is one at least who interprets southern life in the light of its faith in the progress of the people as a whole. The author seems to have made good use of statistical resources generally. There is some doubt, however, as to the value of the statistics of the census of 1870, many of which are confessedly unsatisfactory, so far as they relate to the southern states. Nor is it quite right to charge up the loss of private property through emancipation as a total loss to the south as a whole. The value of the slave population to the community was transferred from private account to public account, though the transfer caused a considerable depreciation in value, it is true, especially at the start. The great loss in economic resources came through the destruction of war and not through emancipation.

An instructive part of the exposition here given is that which relates to the growth of cities in the south. The author speaks very appropriately of the population of the southern states as being under-municipalized. The fact that the population of the south is predominantly rural, renders all the more formidable the problem of illiteracy. As he points out, however, the schools, in spite of all their difficulties, are gaining on illiteracy. There is not a state in the south which is not largely reducing its illiteracy. Within the years 1880 to 1900 there was a marked progress in this respect. In New York and Pennsylvania and Massachusetts the total number of male illiterates increased perceptibly within this period. Illiteracy, therefore, is not a sectional, but a national problem; more than six millions of our people can not read and write. In the chapter on 'Industrial Revival and Child Labor' the author cuts the ground out from under the opponents of constructive legislation by regarding children as an educational rather than as an industrial asset.

Wolf von Schierbrand's volume on 'Russia, Her Strength and Weakness,' is a vivid description of economic and social conditions, studied from the standpoint of Russia as an expanding world power. While the work is highly instructive, in fact one of the best short volumes on this most interesting people, some of its statements evidently need qualification. It is a mistake, for instance, to say that there has not been any industrial

progress in Russia for the space of one hundred and fifty years. The author deals intelligently with Russia's relation to Asia. It is the trend of this part of imperial policy which, in his view, shackled economic progress in European Russia.

In the light of the increasing national debt, Russian finances are analyzed and the effect shown of the debt upon the industrial development of the country. Numerous foreign loans have made it necessary to export more largely than ever in order to pay the interest on public obligations. Lack of private initiative has made it necessary for the government to enlarge its economic functions by absorbing its industries, transportation facilities and such mercantile pursuits as the liquor traffic. The extensive borrowing from abroad has brought into the industrial life of Russia a large number of captains of industry of foreign origin. These industries are, therefore, grafted upon from outside, rather than an organic growth from within the nation; hence they are of an unsatisfactory character from the standpoint of profits. Not only has industry suffered severe relapse, but agriculture, still the essential feature of Russian enterprise, finds nearly every one of its economic features exhausted. The peasant population as well as the landlords are without the surplus return necessary to keep up the land, the soil of the black belt is decreasingly remunerative and peasant wages average ten cents per diem—an index to growing poverty.

The decay of the nobility has left rural life without its earlier leadership. Absenteeism is a curse here, as formerly in Ireland. The church is no longer the vitalizing force in the life of the people and their morals it might be reasonably expected to be. Much is anticipated from the growth of a middle class. The government finds itself between the nether millstone of internal strife and the upper millstone of endeavor to Russify the foreign population. The course of progress is checkered by the ruling classes aiming to get control of the bureaucratic system, each to carry out a different program.

The chief reforms needed, according to this analysis, are the abolishment of the Mir, enlargement of the powers of provincial chambers and greater local autonomy.

This book is strikingly similar in narrative and incident, to the excellent volume of von der Brüggen entitled 'Das Heritige Russland,' published a few years ago in Germany. Probably the main criticism of the book is that the author has used his observation admirably, but has not equally well cultivated the art of appreciative insight.

In the classification of our libraries there is a rapidly increasing output of books on the subject of the world's politics. The center of interest in this sphere of international activity is invariably found in the subject of markets. Industrially equipped as national society is now, each of the leading industrial powers is interested in enlarging its foreign markets. If in ten months the industrial equipment of such a nation can supply enough for home needs in any particular commodity, this particular industry has before it the alternative of two months of idleness or of finding markets capable of absorbing the surplus. The former alternative spells industrial depression; the latter, commercial expansion. This is the argument as applied to the United States, which pervades von Schierbrand's recent volume on 'America, Asia and the Pacific.' His thesis is by no means novel—'that the Pacific during this century is bound to become what the Atlantic was during the eighteenth and nineteenth and the Mediterranean during the twenty-five centuries preceding.' For the rôle of leadership the competition lies among Great Britain, Russia, Japan and the United States. "The United States is the nation best equipped for the coming race in the Pacific. American expansion in the Pacific is something absolutely necessary to safeguard our further national development, and to preserve us from the curse of the ill-balanced production and all its attendant evils." The peg on which the author hangs so many arguments in the grouping of his facts is the Panama Canal.

It is useless to talk about our commercial supremacy in the Pacific, which is the author's major theme, with the insignificant ocean-going tonnage now afloat under the American flag. There is no economic justification for

this vaunting ambition to rule the seas. As one of the elements of the Pacific problems this deficiency in a merchant marine is being recognized, but not by any means with deserving importance, as part of the program laid down for the author's adopted country to follow. In this view it is naval efficiency, not a merchant marine, which shall dominate in the development of the Pacific and of the people on its shore frontage east and west. Is it not, however, a strange reversal of economic reasoning to say that, given a navy, a carrying trade will follow?

Moreover, out of the few lines of shipping of American registry it is the exception to find one that is on a sound paying basis. This is particularly true of lines on the Pacific. The fact is that a naval policy such as the United States is now carrying out only indirectly contributes to the creation of a merchant marine. It has resulted in developing the industry of iron and steel shipbuilding and thus contributed to the reduction of the initial cost of inaugurating this industry. But it does not seem to have reduced the comparative cost of producing ships at home. It has likewise created a prestige for the country and thus for its commerce in foreign parts. But apart from these advantages of a subsidiary character, a big navy is no guarantee of a big carrying trade on the ocean. It is quite too much to assume, as the author does, that with a navy the revival of our shipping will come of its own accord (p. 315).

The public must nevertheless recognize in this volume a penetrative insight into the economic possibilities of Russia in her relation to the United States. Possibly most recent books on Russia have been written from the official car-window standpoint. Here the chapter on 'Little Known Facts about Russia' (pp. 128–139) is worth whole volumes of sophomoric travels.

Russia's conquest by railroad has been for the purpose of opening an ice-free port and of closing Asiatic territory against foreign trade, the more effectively to control the economic processes of her internal policy. From this basis her influence in the Pacific as a competitor with the United States has to be foreshadowed. "It is quite safe to say," says von Schierbrand, that, "as economic enterprises, these Manchurian roads will prove even more pronounced failures than the Transsiberian has so far proved. Viewing them merely from the angle of Russian aggressive policy, of military strategy, and as a visible sign of Russia's expanding political power, they may, however, prove a success. On the other hand, even in this limited sense, they may eventually become a white elephant for Russia. The final issue of this present war will determine that question. For a country so poor in capital as Russia, a country with a home population whose most crying material needs are insufficiently supplied, these Manchurian roads are, economically considered, a gigantic folly."

Nevertheless, by a system of rebates on exports and of bounties in the form of reduced railway rates to the frontier, Russia has again and again succeeded in establishing and holding a footing in some of the markets supposed to be largely in control of her competitors. Hence the author probably takes too short a period of time into account as the basis of this conclusion.

Colquhoun's 'Greater America' is an incisive analysis of the subject of geographical expansion of the United States and the political and economic problems and responsibilities arising therefrom. Whoever has read his 'Mastery of the Pacific,' 'China in Transformation' and 'Overland to China' will recognize the well-reasoned weighing of essential facts and relations in which this work abounds. The shifting of the center of gravity of world politics from the Atlantic to the Pacific has everywhere raised the question, What part shall America play? 'Greater America' is more than continental United States; Greater America is a world power with problems of imperial importance upon her hands. It is in this latter rôle that a new class of social and economic problems is presented to the United States. They include political questions of foreign relations, of relations with alien peoples, of national defense, of government of dependencies. All of these in the author's view depend for right solution

on the efficiency and purity of administration. The *social* problems of America, as he presents the case, center chiefly around the worship of the golden calf (p. 4). The racial problem, the practical stagnation of the native born and the rapid increase among the poor aliens, make it advisable to take steps to preserve the ascendency of the Anglo-Saxon type of America (p. 6). Otherwise an undesirable modification of national character will take place. The nation is now indescribably heterogeneous. At a time when its larger tasks require internal unity and progress (p. 23) the nation is harassed with problems of racial relations. With the Indians the result has been far from satisfactory. With the negroes, the racial adjustment is a 'burning' question. The only solution offered is educational; but American education is materialistic in its trend—a statement to which exception might well be taken. Instead of unity we have an ever-widening gap between capital and labor (p. 35).

In the chapter on America and colonization, the six motives of colonization are classified as trade, conquest, adventure, overflow of population, religious persecution and political rivalries—all of which have to some extent figured in the territorial expansion of the United States, from the Atlantic seaboard across the continent, thence to Alaska, to Hawaii, Samoa, the Philippines and Porto Rico, giving rise to two great extensions of control: (1) Pacific expansion and (2) Caribbean expansion. In both of these the greatest problem is that of dealing with alien races.

In the Philippines the author contends that our idealism has led us to overlook the common sense requirements of the situation (p. 111); the Philippines wanted peace, good government and commercial prosperity; America has given them institutions and legislation; after three years' occupation not one yard of railroad has been begun; only one wagon road is in process of construction; no canals nor deepening of rivers has been undertaken, nor any improvement of harbors, except at Manila (p. 109). This seems to be rather a one-sided judgment. Certainly the Philippines have been given peace. Certainly the best government they have ever had has been given them, and the basis laid for commercial prosperity by the settlement of the land question, which was one of the chief causes of the revolt under Spanish rule.

In the Caribbean expansion of the United States, Cuba and Mexico are the two great considerations. The economic dependence of the one and the economic absorption of the other will be accelerated by the construction of the Panama Canal. But the problematic aspect of Caribbean expansion is the fate of the holdings of European states in this part of the world.

'Great Britain apparently can not help her island colonies. America does not want them.' The trans-isthmian canal, however, enhances their value to the owners of the West Indies, strategically. The hope of closer affiliations with Canada is still regarded as a realizable solution, because the two countries are economically complemental. For Great Britain the Caribbean question is a crucial one. Will these islands between the upper millstone of American indifference and the nether millstone of British inability to give them economic prosperity ultimately fall under the control of America? Cuba the author regards as so incapable of working out her economic salvation that without American energy and capital the island can not be developed. But though the United States gave Cuba education and sanitation, she has not been able to emancipate herself from an economic depression which may yet force the island to seek incorporation into the Union. "Are the other Caribbean islands to go the way of Cuba?" (p. 190). Are the Central republics to pass within the sphere of American control? And if so, what stands in the way of a still wider sweep of Pan-Americanism embracing Canada and the southern continent? In the chapter on Canada and Pan-Americanism the commercial situation is considered as requiring that people to have reciprocity either with the United States or with Great Britain. The United States rendered futile two earnest efforts by Canadian commissions (1891 and 1896) to establish reciprocal trade relations with us. Meanwhile the trend of Canadian

economic development has been toward closer relations with Great Britain and away from the United States. Now if reciprocity is wanted it has to be paid for at a higher price. Great Britain is bending her efforts to aid Canada in her ambition for economic independence of the United States.

One of the ominous signs of the times is the increasing dependence upon navies as a factor in commercial competition. "There can be no question that naval expansion is the dominant note in world policy to-day." Here we are brought face to face with the purpose for which this book was written, namely, to rouse America to the realization that her scope of development as a commercial power in the Pacific depends on her attitude toward the Russian policy of territorial expansion over Chinese territory. Russia's ambitions "may be briefly summed up as being chiefly inimical to the United States in that they are essentially monopolistic. * * * Russia with her program of territorial expansion, military achievements, closed ports, autocratic government and non-progressiveness is a menace to the world" (p. 358).

The assured sovereignty of China seems to be the only basis of permanency to far eastern peace and prosperity (p. 381). The breaking up of China would jeopardize Japan's position, because it would mean an ascendency of Russia and her sympathizers, Germany and France. In our author's view Russia's advance long since passed the defensible limit where British and American interests are impaired. These two interests he groups under the term Anglo-Saxon, and asks:

> What course can be suggested which would best serve the interests of Anglo-Saxondom? * * * Were her expansion the legitimate expression of internal growth and progress, as has been that of the United States, it would be unreasonable to adopt a hostile attitude towards it. Even from the point of view of ethics the territory hitherto conquered or annexed by Russia is probably better off under her than under half savage khans. But Russia's expansion is no longer legitimate. She has reached her objective, the Pacific Ocean, and has not paused to develop or organize the vast territories she has occupied; she has in no case laid the foundation of a future of freedom and prosperity for the conquered peoples. She has already imposed a cast-iron system and planted military colonies to keep things in order. She has no excuse save her own insatiable ambition and land hunger.

JOHN FRANKLIN CROWELL.
WASHINGTON, D. C.

SCIENTIFIC JOURNALS AND ARTICLES.

IN the November number of the *Botanical Gazette* Edward C. Jeffrey describes a new fossil sequoia from the Auriferous Gravels (Miocene) of the Sierra Nevada Mountains. He emphasizes his previously expressed view that the sequoias have originated from the Abietineæ.—George H. Shull publishes the results of his second season's study of the place-constants for *Aster prenanthoides* at Clifton, Ohio. This second collection was made in 1903 from the same area that supplied material for a quantitative study in 1900. The bracts, rays and disk-florets were studied quantitatively and the results compared with those of the earlier study.—B. L. Robinson describes 'A New Sheep Poison from Mexico,' which proves to be a new species of *Bouchetia*.—Elias Nelson publishes three western species of *Agropyron*.—Conway MacMillan describes some very interesting British Columbian dwarf trees. They grow on the rocks close to the sea but outside the influence of the surf, and represent three species: *Picea sitchensis*, *Tsuga heterophylla* and *Thuja gigantea*. One of them was less than two feet high and was 68 years old; another less than a foot high was 86 years old; and the third about a foot high, with a trunk one inch in diameter, was 98 years old.—A. C. Life describes some interesting results from an injury to *Ambrosia*, the chief result being that the primordia usually producing stamens and ovules produced vegetative shoots.

WE learn from *The British Medical Journal* that arrangements have been made with the Syndics of the Cambridge University Press to begin the issue of a *Journal of Agricultural Science*, under the editorship of Messrs. T. H. Middleton, T. B. Wood, R. H. Biffen, and A. D. Hall, in consultation with other gentlemen. The journal will publish only definitely scien-

tific work in agricultural science, and will not include the results of the ordinary trial of manures and varieties for demonstration or commercial purpose. It is proposed to issue the journal as material accumulates, aiming at quarterly parts of about 100 royal 8vo pages, four parts to constitute a volume. Among those who have promised to support the journal are: Professor H. E. Armstrong, F.R.S., Professor M. J. R. Dunstan, Dr. Bernard Dyer, Professor Liveing, Mr. A. E. Shipley, Dr. J. Augustus Voelcker, and Professor Marshall Ward. The first number will be published in January, 1905.

SOCIETIES AND ACADEMIES.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

The 589th regular meeting was held October 29.

Father Hagen, of the Georgetown Observatory, gave an account of 'Astronomy and Mathematics at the International Congress of Arts and Science,' speaking of the papers read, the persons present, the exhibits in various parts of the grounds and the formal and informal gatherings. Two great European congresses held just previous to that at St. Louis kept away many of the expected visitors.

Mr. C. E. Van Orstrand, of the Geological Survey, then presented a paper on 'A Load-Strain Function for Finite Strains.' The results of numerous experiments were summarized as showing that the load-strain curve is in general convex to the axis of loads, although in some instances there is one point of inflexion. Since matter is indestructible, the ordinates of the curve between the points of rupture for tension (x_t) and compression (x_c) are necessarily finite and positive. Hence the load-strain function can contain no zeros and no negative values between the limits x_c and x_t. There is a point of discontinuity at x_t, and for certain substances there may also be a point of discontinuity at x_c. Functions satisfying these conditions were defined by means of the function-theory. A special form of the most general equation is

$$y = (be^{c(x_t - x)^n} + k)^{-p},$$

where y = strained length and x = applied load.

For the case of perfect elasticity, $x_t = +\infty$, and a particular form of the equation is

$$y = e^{cx},$$

a relation which has previously been deduced, but by a wholly different method.* It was shown that this equation represents the data of observation to a high degree of accuracy within the limits ordinarily defined as perfectly elastic. The materials selected were vulcanized India rubber† and various kinds of metallic wires.‡

A letter from Dr. Becker was read expressing his appreciation of Mr. Van Orstrand's investigation.

Mr. C. W. Waidner, of the Bureau of Standards, gave the results of numerous determinations by himself and Mr. G. K. Burgess, of 'The Temperature of the Electric Arc.' A photometric method was used based on Wien's law and the instruments were calibrated at higher temperatures than had been done heretofore, so the uncertainty from extrapolation was reduced; the results were very accordant and gave about 3700° C. An increase of 70° to 80° was found when the current forming the arc was raised from 15 to 30 amperes.

Charles K. Wead.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

The 158th meeting of the Society on November 9 had the following regular program:

Mr. S. F. Emmons spoke of copper ores in Carboniferous limestone in the region of the Grand Canyon of the Colorado, some of which he had an opportunity of visiting during the past summer. Their origin had been ascribed to the leaching of the copper from the red sandstones which once overlay them but are now eroded away. He used these occurrences as a text to discuss the general question as to whether the widespread occurrences of copper in the Permian and

* 'The Finite Elastic Stress-Strain Function,' Dr. George F. Becker, *Am. Jour. Sci.*, 1893.

† Watertown, 'Tests of Metals,' 1893.

‡ 'Ueber das Gesetz der elastischen Dehnung,' J. O. Thomson, *Ann. d. Phys.*, 3, 1891.

Triassic beds may be more properly considered as of contemporaneous formation with the enclosing beds, or whether they are later concentrations or may have been brought in from some entirely foreign source.

Dilation Fissures and Their Contained Ores. MR. W. H. WEED.

Dilation fissures are the fractures formed by expansion or dilation of a rock mass, as in the alteration of peridotite or other basic rocks to serpentine, a change involving an increase of volume of 20 to 33 per cent. The resulting rock is checked by minor fissures, and often accompanied by crushed areas and by larger fractures with persistent course, slickensided walls and polished balls and shelly serpentine. The lesser fractures extend to relatively shallow depths. The larger are trunk channels for circulating waters. Serpentinization appears to be due to deep-seated ascending waters. Chromite, various nickel ores, and in Italy and Cuba, copper ores (chalcopyrite and pyrrhotite) known to exist in small quantity in the unaltered rock, are presumably dissolved by serpentinization processes and deposited by filling and replacement along the fissures and crushed masses, forming ore deposits.

Evidence of Caves of Put-in-Bay, Ohio, on Question of Land Tilting. MR. M. L. FULLER.

The caves of Put-in-Bay have been long known to the public, but, with the exception of Mr. E. L. Mosely, no one seems to have discussed the evidences which they present as to recent changes of lake level. Daussa's Cave is probably the one which Mosely visited. In this cave there is an underground lake 80 feet long and 40 feet wide, which is connected with and fluctuates with the waters of Lake Erie. The water is several feet deep and on the bottom may be seen a number of stalagmites, mostly broken and discolored as if of considerable age. These submerged stalagmites, which are of open air formation, indicate a rise of the lake water level relative to the land. Three other caves, Perry, Crystal and Paradise were visited during the past summer. Perry Cave is a solution cavern, notable for its broad, low arch, 200 feet or more in diameter, and 5 to 7 feet high. Crystal Cave is an immense geode, 10 to 15 feet in diameter, lined with crystals of celestite up to a foot or more across. Neither of the caves throw much, if any, light on the problems of change of level. In Paradise Cave, however, which has been only recently opened, the stalactites are still preserved and afford more definite evidences. In this cave the stalactites, which are still dripping, are pendant from a sloping roof which dips beneath the surface of an underground lake connected with Lake Erie. There is no break in the stalactitic group between the portions above and below water level, indicating them to be essentially contemporaneous. The fact that those beneath the water level are practically as long as those above would indicate that the submergence was of so recent date that no material addition has taken place to those in the open air since the change of level. The submergence of the stalactites simply indicates a change of level of the lake waters relative to the land and does not in itself afford positive evidence of tilting. The occurrence of submerged tree stumps and other accordant evidences, all testifying to a similar change of level, seem to point to the tilting movement, established by Gilbert as a little less than half a foot to a hundred miles per century, as the cause of the submergence indicated by the stalactites of the caves.

GEO. OTIS SMITH,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 389th regular meeting of the society was held on Saturday evening, October 22, 1904. The following communications were presented:

The Insect-Catching Grass of Cuba. E. A. SCHWARZ.

With the beginning of the rains in Cuba, countless swarms of insects appear. At this time also, a grass becomes common, which catches multitudes of the insects in its flowering spikes. They are caught day and night, and in incredible numbers.

The spiny involucre of the spikelets of the

grass presents a bristling array to all comers. Wings of insects alighting or flying within reach are pierced and entangled by the minutely barbed spines and become inextricably matted. Sometimes an insect is caught by the leg. It is not the weak insects only which are caught. Numbers were caught of *Pyrophorus noctilucus* Linn., a luminous snapping beetle, so large and strong that it can be held in the hand with difficulty. While most insects can not free themselves once they alight on this grass, two large ones do so with impunity, an earwig, *Apterygida linearis* Esch., and a bug, *Œbalus*. Minute insects are not caught, and no Orthoptera or Lepidoptera. There seems to be no possible advantage to the grass in its capture of insects.

The grass is *Cenchrus echinatus* Linn., a great pest in the rich soils along the edges of sugar cane fields. It is found in the West Indies and in southern Florida.

A Very Curious Plant from Mexico. J. N. Rose.

The plant in question is a large pumpkin-shaped object, or giant puff ball, somewhat flattened, with the bark of an oak. A few weak roots from the under side form a connection with the ground. The upper surface has a few groups of crowded stems which bear a few linear leaves. A broken specimen shows the interior to consist of a very pithy tissue, with a few roots traversing it from the clusters of stems above to the point of exit below.

Portions of the corky layer were submitted to various experts who could not agree as to whether it was of fungus origin, or caused or made by the insects inhabiting it. It is, however, probably not of pathological origin.

The plant is evidently of the lily family, genus *Nolina*, possibly species *humilis*. It is commonly called by the Mexicans 'palma.'

The Segregation of Fresh-Water Fishes. Theo. Gill.

One of the most remarkable facts in paleontology is the abruptness of the appearance of many families of fishes and especially of the fresh-water families of the great group of ostariophysans. This group or superorder contains the orders of Plectospondyles and Nematognaths. It is only within a little more than a decade that the relations of their families have been recognized, the plectospondyle families having been previously widely dispersed, the cyprinids and three related families having been placed in one section, the charocinids and erythrinids next to the salmonids, and the electrical eel and gymnotids next to the eels. Now, all these forms as well as the nematognaths or catfishes have practically no paleontological history, the earliest known, *Bucklandium* of the Eocene, being evidently a true silurid in a restricted sense. There are no intermediate forms, no generalized types known. When and how did they originate?

Both the Plectospondyles and Nematognaths are more diversely represented in South America than elsewhere and it appears to be most probable that the ancestral forms were developed in what is now South America or in regions of the southern hemisphere lost in the waters of the Pacific or Atlantic. The origin may have commenced as far back even as the Devonian period. It may be recalled that ceratodontids are so closely related to recent forms that for a long time they were combined in the same genus and that no remains of species have been found in beds between the Jurassic and Pliocene Tertiary. What is true of ceratodontids may be true of other fishes.

The salt-water catfishes must be regarded as estrays from the fresh-water types that have accommodated themselves to new conditions.

The Exhibit of Living Animals at the St. Louis Exposition. A. B. Baker.

More effort was made to exhibit living animals at the St. Louis Exposition than at previous expositions. The National Zoological Park of Washington made a particularly good display of birds in a large cage divided into two compartments, one for land birds and the smaller water birds, and the other for the large water birds.

The exhibit was largely an experiment, as it was not known whether so many birds could be displayed on so large a scale. It was a success, however, the mortality, even among

the small birds, being very low. The public interest was very great.

The fish exhibit was large. Some difficulty was experienced at first in using water that had been chemically treated to render it clear. Harm to the exhibit was avoided by adopting a closed water supply.

The 390th regular meeting of the society was held on Saturday evening, November 5, 1904. Dr. C. W. Stiles spoke briefly of the meeting of the International Committee on Zoological Nomenclature which was held in Berne during the past summer. He stated that the International Code of Nomenclature had been revised only editorially. It is now in press in France and will appear soon in English, French and German.

General T. E. Wilcox, U.S.A., presented an illustrated lecture on 'The Flora of the Western United States and Alaska.' He discussed particularly the plants of parts of the Rio Grande Valley and southeastern Arizona. Incidents of a long period of observation were related and the peculiarities of various desert plants mentioned. Especial reference was made to the effects of aridity, irregularity of rainfall and rapid evaporation. Medicinal and otherwise useful plants were particularly mentioned. Notes on certain plants of Alaska, a more humid region, were also given.

WILFRED H. OSGOOD,
Secretary.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE 152d regular meeting was held October 13, 1904, at the Cosmos Club. The program for the evening was as follows:

The Action of Ammonium Chloride on Sulphur Tetrachloride. P. FIREMAN.

A Comparison of the Wet and Crucible Fire Methods for the Assay of Gold Tellurides, with Notes on the Errors Incidental to the Operation of the Fire Assay and Parting. W. F. HILLEBRAND and E. T. ALLEN.

The authors showed that the fire assay for telluride gold ores, with proper precautions, is accurate. Other errors in fire assays, especially the volatility of gold during cupellation and the loss of gold in parting, were investigated. In regard to the former the error was shown to be much larger than has been formerly supposed. The solubility of gold in nitric and nitrous acid which has been claimed by some authors was shown to be entirely negligible.

An Examination of Lard from Cotton Seed Meal Fed Hogs by the Phytosterin Acetate Method of Bömer. L. M. TOLMAN.

The author examined fifteen samples of lard prepared from hogs which had been fed on cbtton seed meal. All of the samples gave positive tests with the Halpen reagent but in none of them could phytosterol be found. This confirmed the work of Solstein. It was found, however, that small amounts of added cotton seed oil could be detected by this method. Also that cotton seed oil that had been heated to destroy the Halpen reaction could be detected.

L. S. MUNSON,
Secretary, pro tem.

THE 153d meeting was held November 10, 1904, at 8 o'clock in the assembly hall of the Cosmos Club. The president, Dr. E. T. Allen, called the meeting to order. After the election of Messrs. H. N. Stokes and S. S. Vorhees as councilors for the ensuing year, the following program was presented:

The first paper, entitled 'Calcium Sulphate in Aqueous Ammonium Sulphate Solution,' was presented by Dr. E. C. Sullivan. The results of the experiments showed that as the concentration of the ammonium sulphate increases the solubility of the calcium sulphate at first diminishes, and then increases. The general appearance of the curve corresponds to that of the solubility of calcium sulphate in sodium sulphate solutions, reported by Cameron at a previous meeting of this society. Conductivity determinations of the solutions seem to show that the concentration of the non-dissociated calcium sulphate does not remain constant.

Under the title of 'A Statistical Analysis of the Chemical Industries of the United States,' Professor Charles E. Munroe reviewed the history of the census of manufactures in the United States, describing briefly the methods for securing and classifying the returns and pointed out that while the sta-

tistics published for the entire manufacturing industries of the country taken as a whole are accurate to a high degree, the statistics for any single industry forming a part of this whole may, owing to the fact that to prevent duplication an establishment manufacturing a variety of products is classified according to that one of its products having the maximum value, be less accurate. He believes that this inaccuracy in presentation may be greatly remedied by a further analysis and segregation of the published data and that this analysis may be so extended as to show the disposition made of the products. This last process appears not to have been heretofore attempted, yet the results should prove to be not only of general interest but of special value in legislation and litigation where the rule of 'principal use' obtains and in manufacturing and other policies where the question of substitution may arise, while in the census work itself this data would furnish additional checks on the returns and the results. Examples of the results of such analyses as pertained to the wood distillation and the sulphuric acid industries were presented.

The last paper of the program, entitled 'Memories of Bunsen and Heidelberg,' was presented by Dr. W. F. Hillebrand. The speaker gave a description of the Heidelberg chemical laboratory as it was conducted by Bunsen thirty years ago. Personal reminiscences and experiences were recalled.

A. Seidell,
Secretary.

NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

At the November meeting Professor Underwood presided. Dr. W. M. Wheeler, of the American Museum of Natural History, was elected chairman, and M. A. Bigelow, of Teachers College, Columbia University, secretary, of the section for the year 1905. Papers were presented by W. E. Kellicott, M. A. Bigelow and F. E. Lloyd.

Dr. Kellicott's paper, on the 'Development of the Venous System of *Ceratodus*,' pointed out many similarities to the amphibian. These similarities are so numerous and exact that it seems impossible to believe that the Dipnoi and Amphibia have not arisen as a common stock which has separated later into these groups. The adult relations and the mode of development of the vena cava of *Ceratodus* indicate that this vessel is not to be looked upon as one of the hepatic veins which has made a new connection with the posterior cardinal vein, but that its anterior portion develops as a short cut by way of which the blood from the mesonephros may be carried to the heart after the atrophy of the pronephros and the associated veins.

Mr. Bigelow briefly described some observations on eggs of the crustacean *Hippolyte* subjected to slight pressure during cleavage. While the normal cleavage is total, pressure prohibited the formation of cell-boundaries, and unsegmented eggs with 2, 4, 8, 16 and 32 nuclei were obtained. When the pressure was removed the cell-boundaries soon appeared. The cleavage of this egg under pressure exhibits some striking resemblances to the normal superficial cleavage of eggs of allies.

Professor Lloyd described the conditions for botanical research at the Desert Botanical Laboratory in Arizona. Many photographs were exhibited to illustrate descriptions of the peculiar flora in the vicinity of the laboratory and of the method of conducting experiments, especially those concerned with the relation of desert plants to water.

M. A. Bigelow,
Secretary.

CLEMSON COLLEGE SCIENCE CLUB.

The forty-ninth regular meeting of the Clemson College Science Club was held in the lecture room of the electrical laboratory, October 28, at 8:30 P.M. Dr. J. H. James gave a brief report of the summer meeting of the American Chemical Society, reviewing informally the more important papers. Professor W. M. Riggs gave an account of a new food product, practically a popped rice, prepared by a process invented by Dr. A. P. Anderson, a former member of the Clemson College faculty; and now being exhibited at St. Louis. The principal paper of the evening was by

Dr. F. H. H. Calhoun, who discussed two features of glaciation in the northwestern part of Montana. The first was as to the relative ages of the ice of the Kewatin ice sheet, and the ice of the mountain glaciers. The second dealt with the question of the Albertan drift period. From data gathered in the three river valleys, the conclusion was reached that the mountain ice was the older of the two sheets. In the valley of Birch Creek a valley train from the mountain glacier was found beneath lake deposit formed in front of the Kewatin ice sheet. In the valley of the Two Medicine River, the moraine of the mountain ice was covered by lake deposit, and in the same valley further east, the moraine of the Kewatin ice sheet rested on a valley train from the mountain glacier. In the valley of the Belly River, the mountain drift was found under the Kewatin drift. Dr. Calhoun also arrived at the conclusion that the so-called Albertan drift sheet of Dawson was nothing more than old river gravels picked up by the Kansan ice sheet, and now found at the bottom of that drift sheet. This paper will be published by the U. S. Geological Survey.

HAVEN METCALF,
Secretary.

ONONDAGA ACADEMY OF SCIENCE.

AT the last meeting of the Academy, held in Syracuse, N. Y., October 21, Dr. H. C. Cooper addressed the meeting on 'Physical Chemistry and its Service to the Other Sciences.'

Physical chemistry was shown to have an important bearing on physiology in virtue of the application of the modern theory of solution to vital processes and the discovery of the similarity of behavior between enzymes and inorganic contact agents. The work of van't Hoff and his pupils on chemical equilibria in various geological formations, and the determinations of the transition-points of geologically important substances were commended to the study of geologists. The speaker also showed how, by physico-chemical methods, various physiologically and mineralogically important substances have been prepared in the laboratory.

J. E. KIRKWOOD,
Corresponding Secretary.

WELLESLEY COLLEGE SCIENCE CLUB.

THE first regular meeting of the club for the year was held at the Whitin Observatory on October 18. Professor Ellen Hayes presented a paper on 'Nature the Master of Man.'

The second meeting was held in the Physics Lecture Room on November 8. Mr. Albert E. Leach, of the Massachusetts State Board of Health, read a paper on 'The Purity of our Food.'

GRACE E. DAVIS,
Secretary.

DISCUSSION AND CORRESPONDENCE.

DAVENPORT'S 'STATISTICAL METHODS.'

TO THE EDITOR OF SCIENCE: In the preface to the second edition of Dr. C. B. Davenport's useful 'Statistical Methods' occur the following sentences: "Especial attention is called to Table IV., which is an extension of Table IV. of the first edition that was calculated by Professor Frederick H. Safford, and appears to have been the first published table of the normal probability integrals based on the standard deviation. More recently Mr. W. F. Sheppard has published in *Biometrika* a similar table. * * *"

In justice to Mr. Sheppard I wish to point out that his tables in *Biometrika* are only the extension of the table which appears in his memoir read before the Royal Society in 1897 and issued in 1898 (cited by Dr. Davenport, second edition, pp. 84, 101). Dr. Davenport's first edition of his 'Statistical Methods' did not appear until 1899. Thus there can be no claim as to priority for Professor Safford's table of 1899. If we desire to be absolutely accurate in the matter, we shall probably not attribute the first published table even to Mr. Sheppard, still less to Professor Safford. On the other hand, Mr. Sheppard's table at present stands quite unsurpassed for its range, accuracy and the number of decimal places in the probability integral.

KARL PEARSON.
UNIVERSITY COLLEGE, LONDON, ENGLAND,
November 5, 1904.

CORALS.

TO THE EDITOR OF SCIENCE: I find myself in the position of an author replying to a

reviewer (pp. 503–5, October 14, 1904) with the greater part of whose remarks he is in cordial agreement, and whose work he has ever found to be characterized by the greatest care and the fullest consideration of every point.

My endeavor has been throughout to clearly show the species and to some small degree their variation, *vegetative, continuous* and *discontinuous*. My reason for not publishing *in detail* my observations on the influence of environment on mode of growth of corals was simply lack of means to pay for the necessary illustrations. I kept careful records of a considerable number of species for this purpose, but on reconsideration *now* I am of opinion that any account, or at least the first account, of the same should be written while still on the reef and capable of verifying any point that may arise. The best way would be to take the necessary physical observations in three or four different environments containing the same species of corals, to carefully chart the character and organisms of the same, and to show photographically their variations. The specimens, from six or eight square yards of each, being subsequently mounted in the positions in which they grew in respect to one another and other organisms, would form most instructive and unique exhibits in any museum which had the funds and enterprise to undertake such a work. The best locality would undoubtedly be the West Indies, since its broader physical conditions are, perhaps, better known than those of any other suitable coral-reef region, and because it is the home round which coral literature is entwined.

I used the term *continuous* in respect to variation in its ordinary sense, excluding, however, *vegetative* variation, that due to the action of the environment on the organism during its growth. I do not restrict the term to series from one locality grading into those from others, as it may be equally well seen in series from one locality, or even from one environment of the same. Where the *modes* of series from diverse localities differ in certain characters from one another, as seems to me frequently to be the case, and yet the individual specimens of the different species merge, we would seem to have before us *true* cases of natural selection acting on *continuous* variation. Yet—and this is the point—*neither new species nor new genera seem to result from this action.*

In attempting to adopt a classification more in accordance with our present ideas than that of Duncan, I found that I had in the works cited by Mr. Wayland Vaughan less than a quarter of the information required to turn out a 'good job,' and less than a sixth of the necessary specimens in Cambridge required to complete the other three quarters. Under the circumstances I treated each genus by itself, satisfying myself first as to its validity, merely adopting a well-known order for convenience of reference. I tried to lay the foundations in the species themselves, and I left the gross classification in the hope that some one, who has the specimens—I know no one more capable and with wider knowledge of recent and fossil corals than your reviewer—might be induced to consider the whole. Further, in the present state of our knowledge I found it hopeless to work out a *scientific* classification, based, as I consider such must be, on the polyphyletic origins of the so-called astræid, fungid and perforate groups.

I have no doubt Mr. Wayland Vaughan is correct in respect to the generic names to which he refers. I have, however, considered the identity of *Mussa* with *Symphyllia* and of *Cœloria* with *Mœcendrina*, and in spite of Professor Verrill's and Mr. Wayland Vaughan's opinions I still separate them; the anatomy and development of their polyps and coralla should be compared and would settle the question.

J. Stanley Gardiner.
Cambridge, England.

Some Further Comments on the Guatemalan Boll Weevil Ant.

In his reply to my remarks on the feasibility of establishing the Guatemalan boll weevil ant in Texas, Dr. O. F. Cook shows how dubious are the claims for the much-advertised efficiency of this insect. Clearly there are two distinct problems involved in the discussion; first, the establishment of the boll weevil ant in the southern states, and

second, its efficiency as a boll weevil destroyer. My paper dealt largely with the former, since it is, of course, the *conditio sine qua non* of the latter problem. Dr. Cook calls my remarks a '*post facto* prognosis,' wishing, I suppose, to create the impression by this *contradictio in terminis*, that his *Schmerzenskind*, the kelep, to which the Department of Agriculture has been standing sponsor, is doing remarkably well. I will pass over the fact that this implication is hardly borne out by the latest reports from the field of experimentation, and consider some of Dr. Cook's statements.

He says that 'it was obvious to Professor Wheeler from the first that the case was hopeless.' This statement is false, inasmuch as neither I nor anybody else outside of the Department of Agriculture could have had *any* opinion on this subject till very recently, for the very simple reason that the scientific name of the ant was not made public by the Department till its great value as a boll weevil destroyer had been boomed in all the newspapers of the country. The kelep, as Dr. Cook informs us, was discovered 'on the cotton April 20, 1904, in Alta Vera Paz, Guatemala, and its efficiency as a destroyer of the Mexican cotton boll weevil was demonstrated the following day.' But even in his official report, which could hardly have been published before August 1, the scientific name of the ant was not given and it was several weeks later before I could ascertain it.

Dr. Cook further says that I have disregarded 'several facts which might have mitigated the confidence of the prophesy.' The first of these is a straw fact of Dr. Cook's own manufacture, namely the supposition that I am of the opinion that *Ectatomma* is very much like *Odontomachus*.* I am at a loss to know how I could have given this impression, as the only time I associated these genera directly was when I considered *Odontomachus* to be more dominant, more variable and more widely distributed than other Ponerinæ, *Ectatomma*, of course, included. This statement has not even been met, to say nothing of having been refuted, by Dr. Cook.*

It is, in fact, Dr. Cook himself who should be glad to have the kelep more like *Odontomachus*. At any rate, he makes a futile attempt to show that the kelep is a dominant, 'enterprising' ant, with large colonies (*i. e.*, prolific) and highly adaptable. But closer examination shows that the kelep is like the other Ponerinæ in being below par in all of these respects. It is 'dominant' only in the cotton fields of Guatemala, and very rare or absent elsewhere in that country. It is 'enterprising' although 'compared with the nervous haste of many other species, its motions

* Dr. Cook is 'ready to follow Mayr and Ashmead in assigning these genera to separate families.' In other words, the genus *Odontomachus* should be separated from the Ponerinæ (or Poneridæ as Cook and Ashmead persist in calling the group) and made the type of a distinct family, the Odontomachidæ. This was Mayr's opinion many years ago, but it is probable that he now believes with the eminent myrmecologists Emery and Forel that *Odontomachus* (together with *Anochetus* and *Champsomyrmex*) can not be separated as a distinct family, but has hardly more than tribal value. The only characters on which such a separation could be effected are the peculiar shape of the petiole and mandibles. But the very same kind of a petiole is found in certain undoubted Ponerinæ, like the South American *Leptogenys unistimulosa*, and if the shape of the jaws is such an important character, we should have to make several families out of such genera as the myrmicine *Strumigenys*, some species of which, like *S. louisianæ*, *grandidieri*, etc., have mandibles very much like *Odontomachus*. But this would be absurd, hence it is best to let well enough alone. Moreover, the shape of the mandibles in different genera of the Ponerinæ (*e. g.*, in *Harpegnathus*, *Thaumatomyrmex*, *Mystrium*, etc.) is so diverse that this subfamily would have to be resolved into a great number of families, if we were to follow Cook's example with *Odontomachus*. Undoubtedly this would give a fine opportunity for a display of the *mihi* itch, but the cause of science would be little furthered thereby.

* The larva of *Ectatomma* is much more primitive in its characters than that of many other Ponerinæ, whereas the larva of *Odontomachus* is much like that of the typical genus *Ponera*. This fact, too, has an important bearing on the taxonomic position of *Odontomachus* discussed in the preceding foot-note.

are slow and deliberate (sic!), and, like the so-called praying mantis, it stands for long periods quite motionless, with the antennæ and mandibles extended, ready for something to come that way and be caught.' This must be 'enterprise' as understood by the Jewish tailor of the comic papers who stands in the doorway of his shop waiting for customers.

It seems that I was mistaken in supposing that the colonies of the kelep contain only from 20 to 110 workers, though these numbers were taken from Dr. Cook's own statement concerning the colonies introduced into Texas. We are now told that they (not the colonies in Texas!) comprise between 200 and 300 individuals and that 'there are seldom less than 100 and sometimes 400 or more.' Now even if we put the number at 500, these are still very small colonies, as ant colonies go, and show conclusively that the kelep, like other Ponerinæ, must be either short-lived or much less prolific than other ants, or both.

The adaptability of the kelep, according to Dr. Cook, is 'shown by its association with the cotton for the sake of its nectar, as well as by its skill in stinging the boll weevil.' If this shows anything it does not show adaptability but adaptation, which is a very different matter. The first part of Dr. Cook's statement, together with several of his previous statements, implies that the cotton plant and the kelep live in a state of symbiosis, like that which has been claimed to exist between the South American *Cecropia* tree and the ant *Azteca instabilis*, and between the African and tropical American acacias and the species of *Sima* and *Pseudomyrma* respectively. These classical cases, however, have never been demonstrated to the satisfaction of either the botanists or the myrmecologists. Any one who observes without bias the insects visiting many plants with extra-floral nectaries, like our species of *Cassia, Ricinus, Stillingia, Populus*, etc., will find that certainly in such cases no symbiosis exists. Not only do all sorts of ants, mutillids, bees, wasps, beetles, flies, etc., visit the extra-floral nectaries, but caterpillars, chrysomelid larvæ, etc., may be found feeding with impunity on the lacerated foliage of the plants thus 'protected.' It is possible, of course, that some of the cases of so-called ant and plant symbiosis may be genuine, but before any such statement can be made of a particular case like the cotton plant, we need much more concise, abundant and painstaking observations than have been published hitherto.

I fail to see, therefore, that Dr. Cook has produced any facts that could lead me to 'mitigate' the statements made in my former paper. The kelep is a typical ponerine ant, with all the disadvantages of a fixed and archaic constitution in the presence of experiments that require for their successful execution a plastic and adaptable species. When the kelep has succeeded in becoming a thriving component of the Texan ant fauna there will be time enough to determine whether its strenuous and enterprising efforts can 'add even ten per cent. to the cotton crop'—we will not expect it to chase all the boll weevils into the Gulf of Mexico. Dr. Cook himself admits that 'the chances are still very much against it, no doubt.' This is exactly what I have maintained. Neither I nor any one else blames the Department of Agriculture for following every clue till some 'concrete conclusion' is reached, but the premature and persistent booming of a conclusion which is far from being 'concrete' and has 'chances very much against it' can only discredit the Department of Agriculture, Dr. Cook and the unsuspecting kelep in the eyes of the general public, the Texan cotton grower and the scientist. I shall have no further remarks to make on the kelep and am satisfied to await patiently the concretion of the conclusions—even till the Greek calends.

William Morton Wheeler.

Are they sympathetic drums?

To the Editor of Science: Some of the African xylophones (marimbas) and those of Central America, which negro slaves introduced there, have resonators—gourds, or cylinders of cane or of bamboo, placed beneath each sounding-bar. Often at the lower end the side of each resonator is pierced with a lateral hole and covered with a thin film or membrane. I have never found a reasonable ex-

planation why this construction was so often made. I had ascribed it to savage fetish, but is there not a better reason for it? I suspect that the film acts as a sympathetic drum, like that of the nyasataranga of India, the onion flute of Europe, and its late reproductions in the kazoo and zobo. In that case, it increases the volume of sound and adds a different timbre to the marimba, as it does to the other instruments mentioned. The same reasons may also be ascribed for the use of the membrane over a lateral hole of the Chinese flute (ti-tzŭ) and other flutes of the far east.

E. H. HAWLEY.

U. S. NATIONAL MUSEUM,
November 15, 1904.

QUOTATIONS.

SCIENCE IN THE BRITISH WEST INDIES.

THE American Consul at Bermuda describes in a United States Consular Report the steps which have been taken to establish there a biological station which will be to North America what the Naples station is to Europe. For several years American naturalists have carried on investigations of the natural history of the Bermudas and the surrounding sea, and have made efforts to establish a biological station in these islands. Upon the advice of the Royal Society, our government has given its assent to the project. The Colonial Government has expressed its willingness to purchase the land and erect the building, and grants toward equipment and support of tables have been made by the Royal Society and the Carnegie Institution. Harvard University and New York University, in connection with the Bermuda Natural History Society, have already commenced work in a temporary laboratory close to what will be the permanent quarters of the station, and the United States Government has been asked to give generous support to the station. America has already founded a tropical botanical laboratory in buildings of the government of Jamaica at Cinchona, and has now secured a biological station, so that it appears as if the Americans are rapidly getting the control of the scientific interests of our western tropical possessions. While we can not but admire the interest shown in the establishment of these stations by universities and colleges in the United States, it is impossible not to regret the apathy with which our home and colonial governments regard such matters. Surely it is the duty of the state to encourage the pursuit and cultivation of natural knowledge throughout the Empire, and to realize the richness of its possessions in material for scientific study as well as in precious minerals. It is a reproach to our nation that a biological station has not been established by us in the Bermudas; for now, instead of American investigators carrying on their work in a British station, we have to face the fact that, though the station will be on British soil, it will belong to the United States, and our own countrymen will be guests in it. So far as the interests of science are concerned, probably this does not matter; for, as Mr. Balfour wrote a few days ago to the translator of his British Association address, community of aim 'binds together the scientific men throughout the world into one international brotherhood." But it should be evident to some of our ministers, at least to Mr. Balfour, who has often expressed sympathy with scientific progress, that it can not be to the advantage of the state for another nation to accept responsibilities which belong to us. Mr. Balfour is gratified at the success of the translation of his address into German, but apparently he does not consider that the interest shown in scientific matters in Germany is due to the active and practical part played by the state in helping scientific education and research. What we want here and in all parts of the Empire is more practical help of the kind given by the United States and Germany to save us from the future regret of lost opportunities.—*Nature.*

ECONOMIC ENTOMOLOGY AT THE WORLD'S FAIR.

THERE prevails in Europe a very proper idea that the United States takes the lead in economic entomology. It must, therefore, have been somewhat surprising to our foreign friends, upon visiting St. Louis, to have found our station collections of insects so poorly

represented. The government exhibit of insects, in the government building, of course, was excellent, and in the forestry building the exhibit of Dr. Felt, and Dr. Smith's collection of mosquitoes were admirable, but in the station exhibits in the Palace of Education there was a woeful lack of representative matter from the various stations. Professor Gillette tells me that he had for the exhibit contributions from California, Connecticut, Colorado, Hawaii, Kansas, Kentucky, Indiana, Idaho, Louisiana, Maine, Maryland, Minnesota, Missouri, Montana, Nebraska, New York (Geneva, Cornell), New Mexico, New Hampshire, New Jersey, Ohio, Oregon, Pennsylvania, Rhode Island, Texas and Virginia. In many instances these representative collections were extremely small. Professor Gillette is by no means to be blamed for this lack of representation, for he has, with the limited means at his command, certainly done all he could to forward this work and both he and Mr. Farmer have installed the material with great care and with resulting good effect. Nor does the writer believe it is due to apathy on the part of the station entomologists, but rather to the fact that the time of the entomologists is so crowded with other exacting work, that no time is left for preparation of any such exhibit as was called for in this connection, nor were funds available. Whatever may have been the cause, the result was an inadequate representation of the interest in economic entomology, and as such it is to be deplored.

In connection with Dr. Smith's exhibit of mosquitoes in the forestry building, which was certainly one of the most complete that has ever been placed before the public, illustrating not only a large number of species, but different phases in the work against the mosquito, we must remark on a colored illustration labeled 'Anopheles in the Act of Biting' or words to that effect. It represents an enlarged figure of a mosquito filled with blood, and with beak inserted, *but the beak and body are at right angles to each other.* While we may be mistaken, we are under the impression that this genus, in biting, always so raises the body that it and the beak are on the same line. In the education building, Professor Stedman had, in addition to his station exhibit of insects and photographs, a good show collection in Missouri's state educational exhibit, and Dr. Fernald had an interesting and instructive exhibit of insects (largely specimens of the gypsy moth and its enemies), insecticides and photographs in the Massachusetts educational exhibit, but the latter exhibit would never be found by an entomologist unless he were guided to it.

F. L. Washburn.
Minnesota State Experiment Station,
November 8, 1904.

MEDALS OF THE ROYAL SOCIETY.

The council of the Royal Society have made the following awards of medals for this year: The Copley medal to Sir William Crookes, F.R.S., for his long-continued researches in spectroscopic chemistry, on electrical and mechanical phenomena in highly rarefied gases, on radio-active phenomena, and other subjects. The Rumford medal to Professor Ernest Rutherford, F.R.S., for his researches on radio-activity, particularly for his discovery of the existence and properties of the gaseous emanations from radio-active bodies. A Royal medal to Professor William Burnside, F.R.S., for his researches in mathematics, particularly in the theory of groups. A Royal medal to Colonel David Bruce, R.A.M.C., F.R.S., for his researches in the pathology of Malta fever, nagana and sleeping sickness, and especially for his discoveries as regards the exact causes of these diseases. The Davy medal to Professor William Henry Perkin, jr., F.R.S., for his discoveries in organic chemistry. The Darwin medal to Mr. William Bateson, F.R.S., for his contributions to the theory of organic evolution by his researches on variation and heredity. The Sylvester medal to Professor Georg Cantor for his researches in the theories of aggregates and of sets of points of the arithmetic continuum, of transfinite numbers, and Fourier's series. The Hughes medal to Mr. Joseph Wilson Swan for his invention of the electric incandescent lamp and various improvements in the practical applications of electricity.

PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE fifty-fourth annual meeting of the American Association for the Advancement of Science, and the third of the 'Convocation week' meetings, will be held in Philadelphia, Pa., December 27, 1904, to December 31, 1904, in the buildings of the University of Pennsylvania. Hotel headquarters have been established at the Hotel Walton, Broad and Locust Streets.

The officers of the local committee are: President, Provost Charles C. Harrison; vice-president, Professor Edgar F. Smith; secretary, Dr. Philip P. Calvert; treasurer, Dr. Samuel G. Dixon; chairman of the executive committee, Provost Charles C. Harrison; of the committee on reception and entertainment, Mrs. Charles C. Harrison; of the committee on hotels and boarding houses, Professor Amos P. Brown; of the committee on meeting places and equipment, Professor Edwin G. Conklin; of the committee on press and printing, Mr. George E. Nitzsche; of the committee on transportation, Mr. Walter Wood; of the committee on finance, Mr. S. F. Houston.

A railroad rate of one fare and one third for the round trip, on the certificate plan, has been granted by the Central Passenger Association, Southeastern Passenger Association, Trunk Line Association and New England Passenger Association. The same rate is expected, and will probably be granted by the Western and the Southwestern Associations. Certificates will also be issued from points in Canada east of and including Toronto. The Transcontinental Passenger Association have on sale daily from Pacific coast points, regular nine months' tourist tickets to Chicago, St. Louis, Memphis and New Orleans, at rates which approximate one fare and one third for the round trip.

The program for the entire meeting will be issued on Wednesday, December 28. Copies may be obtained at hotel headquarters and at the office of the permanent secretary, in Houston Hall. No 'Daily Program' will be issued as at former meetings. The following events may be announced in advance:

Tuesday, December 27, 1904, the regular meeting of the executive committee of the council, consisting of the general secretary, the secretary of the council and the secretaries of the different sections, will be held at noon in the rooms of the permanent secretary, at the Hotel Walton.

Wednesday, December 28, 1904, meeting of the council at 9 A.M. in the auditorium, Houston Hall. First general session of the association at 10 A.M. in the Chapel, College Hall. The meeting will be called to order by the retiring president, Dr. Carroll D. Wright, who will introduce the president-elect, Dr. W. G. Farlow. Addresses of welcome will be delivered by members of the local committee, to which President Farlow will reply. Announcements by the general, permanent and local secretaries. Adjournment of the general session, to be followed by the organization of the sections in their respective halls.

Addresses of the vice-presidents will be given as follows: At 2:30 P.M.—Vice-President Tittmann before the Section of Mathematics and Astronomy, in College Hall. Vice-President Bancroft before the Section of Chemistry, in Harrison Laboratory of Chemistry. Vice-President Russell before the Section of Geology and Geography, in Geological Laboratory, College Hall. Vice-President Mark before the Section of Zoology, in Laboratory of Physiology and Pathology.

The address by Dr. Carroll D. Wright, the retiring president of the association, will be given at 8 P.M.

Thursday, December 29, 1904, at 2:30 P.M.—Vice-President Hall before the Section of Physics, in Morgan Laboratory of Physics. Vice-President MacBride before the Section of Botany, in Biological Hall. Vice-President Baldwin before the Section of Social and Economic Science, in Logan Hall.

Friday, December 30, 1904, at 2:30 P.M.—Vice-President Woodward before the Section of Mechanical Science and Engineering, in Mechanical Engineering Building. Vice-President Saville before the Section of Anthropology, in the Museum of Science and Art.

All meetings will be held in the buildings

of the University of Pennsylvania. The rooms assigned to the various sections of the association and to the affiliated societies are indicated below:

General Meetings.—The opening session on Wednesday morning and the brief daily session at 10 A.M. will be held in the Chapel, College Hall.

Council Room.—The council will meet daily, at 9 A.M., in the auditorium of Houston Hall.

Permanent Secretary.—The office of the permanent secretary will be located on the first floor of Houston Hall. Here will be found post office, registration, and railroad certificate facilities.

Section A, Mathematics and Astronomy.—College Hall.

Section B, Physics.—Morgan Laboratory of Physics.

Section C, Chemistry.—Harrison Laboratory of Chemistry.

Section D, Mechanical Science and Engineering.—Mechanical Engineering Building.

Section E, Geology and Geography.—Geological Laboratory, College Hall.

Section F, Zoology.—Laboratory of Physiology and Pathology.

Section G, Botany.—Biological Hall.

Section H, Anthropology.—Museum of Science and Art.

Section I, Social and Economic Science.—Logan Hall.

Section K, Physiology and Experimental Medicine.—Laboratory of Physiology and Pathology.

American Anthropological Association.—Museum of Science and Art.

American Chemical Society.—Harrison Laboratory of Chemistry.

American Folk-Lore Society.—Museum of Science and Art.

American Philosophical Association.—Logan Hall.

American Physical Society.—Morgan Laboratory of Physics.

American Physiological Society.—Laboratory of Physiology and Pathology.

American Psychological Association.—Psychological Laboratory, College Hall.

American Society of Naturalists.—Laboratory of Physiology and Pathology.

American Society of Zoologists (Eastern Branch).—Laboratory of Physiology and Pathology.

Association of American Anatomists.—Wistar Institute of Anatomy.

Association of Economic Entomologists.—Laboratory of Physiology and Pathology.

Astronomical and Astrophysical Society of America.—College Hall.

Botanical Club of the A. A. A. S.—Biological Hall.

Botanical Society of America.—Biological Hall.

Entomological Club of the A. A. A. S.—Laboratory of Physiology and Pathology.

Fern Chapter.—Biological Hall.

Geological Society of America.—Geological Laboratory, College Hall.

Society of American Bacteriologists.—Laboratory of Hygiene.

Society for Horticultural Science.—Biological Hall.

Society for Plant Morphology and Physiology.—Biological Hall.

Society for Promotion of Agricultural Science.—Logan Hall.

Society of the Sigma Xi.—Houston Hall, Auditorium.

Sullivant Moss Chapter.—Biological Hall.

Wild Flower Preservation Society of America.—Biological Hall.

SCIENTIFIC NOTES AND NEWS.

On the occasion of the birthday of King Edward honors were conferred upon men of science as follows: Mr. W. H. M. Christie, C.B., F.R.S., has been promoted to the rank of Knight Commander of the Order of the Bath (K.C.B. Civil Division). Dr. J. W. Swan, F.R.S., has received the honor of knighthood. The Hon. C. A. Parsons, F.R.S., has been appointed a companion of the order of the Bath (C.B.).

Oxford University will confer the degree of D.Sc. on Dr. Harald Höffding of the University of Copenhagen.

The seventieth birthday of Professor G. H. Quincke, professor of physics at Heidelberg,

was celebrated on November 19. Professor Kohlrausch, of Berlin, was the president of a committee that presented him with an album containing the autograph photographs of leading physicists.

THE Vienna Academy of Sciences has re-elected Professor Eduard Suess as president.

CORRESPONDING members of the Academy of Sciences at Göttingen have been elected as follows: Professors Gustav Retzius, of Stockholm; Ernst Wilhelm Benecke, of Strasburg; Paul Ehrlich, of Frankfort, and Ewald Herring, of Leipzig.

PROFESSOR HENRY S. GRAVES, director of the Yale School of Forestry, has been commissioned by the Bureau of Forestry to undertake inspection work in the Philippines. He will also undertake commissions in India for the Forestry Bureau in the Philippines. He will leave New York on December 3, and return early in May. During the winter Professor Graves's courses will be conducted by Dr. Bernhard E. Fernow, formerly director of the Cornell School of Forestry.

FOREIGN journals state that Dr. Francisco de los Cobos, a physician of Buenos Aires, is in Spain as representative of the scientific societies of Argentina, seeking the support of the Spanish Government for the creation of a Hispano-American University.

DR. CATTO has been awarded the Craggs prize of the London School of Tropical Medicine for his discovery of a new schistosomum parasite of man.

THE Middleton Goldsmith lecture of the New York Pathological Society was delivered at the New York Academy of Medicine, on November 30, at 8:30 o'clock, by Dr. Charles Wardell Stiles, chief of the Division of Zoology, Hygienic Laboratory, U. S. Public Health and Marine-Hospital Service. The subject was: 'Zoological Pitfalls for the Pathologist.'

THE first ordinary meeting of the Royal Statistical Society for the present session was held at the Society of Arts, on November 15, when Sir Francis Sharp Powell, Bart., M.P., delivered an inaugural address.

DR. HENRY S. CONARD, for four years Harrison fellow and now instructor in botany in the University of Pennsylvania, is about completing his monograph of the water-lilies (*Nymphæa*), which has occupied a large part of his time since 1899. The book will be published by the Carnegie Institution of Washington. It is expected to appear in December of this year, or early in January.

THE Walsingham medal, of Cambridge University, for 1903, not having been adjudged, the Special Board for Biology and Geology has agreed to recommend its award as an additional medal for the present year, and the medal has accordingly been adjudged to Mr. R. P. Gregory, B.A., fellow of St. John's, and Mr. Keith Lucas, B.A., fellow of Trinity. Mr. Gregory's essay was entitled 'The Reduction of Division in Plants and its Significance in the Physiology of Heredity.' Mr. Lucas's essay was entitled 'The Augmentor and Depressor Effects of Tension on the Activity of Skeletal Muscle.'

MR. W. H. PICKERING, late chief of the inspecting staff of the Yorkshire and Leeds Mining Districts, has been appointed chief inspector of mines in India.

A CHAPTER of the Scientific Society of the Sigma Xi has been organized at the Case School of Applied Science, with Professor J. W. Langley as president.

THE 'Harben Lectures' of the Royal Institute of Public Health, will be given in King's College, London, on Friday, November 25, December 2 and 9, by Professor John McFadyean, M.B., B.Sc., principal of the Royal Veterinary College, London, on 'Glanders.'

PROFESSOR MARSHALL WARD, F.R.S., has been elected president, and Professor Thomson, F.R.S., Professor Liveing, F.R.S., and Dr. Hobson, F.R.S., vice-presidents of the Cambridge Philosophical Society.

HENRY MCCALLEY, of the Geological Survey of Alabama died at Huntsville, Alabama, of pneumonia on the November 20, 1904, in the fifty-third year of his age. Mr. McCalley was graduated from the University of Virginia with the degrees B.S., C.E. and M.E. in 1875. From 1878 to 1885 he was assistant in

the Department of Chemistry at the University of Alabama and a volunteer on the staff of the Geological Survey. From 1883 to the time of his death he was chief assistant on the Geological Survey, in which capacity he traveled over the greater part of the state, and prepared reports dealing mainly with the coal and iron. He was secretary and treasurer of the Alabama Industrial and Scientific Society; member of the American Association for the Advancement of Science; member of the American Institute of Mining Engineers, and fellow of the Geological Society of America.

The deaths are announced of Forstmeister Schering, formerly professor of mathematics and geodesy in the School of Forestry at Munich; and of Dr. Francesco Chizzoni, professor of geometry at Modena.

We regret also to record the death of Dr. Karl Senhofer professor of chemistry at the University of Innsbrück; of M. J. Macé de Lépinay, professor of physics, and of M. Pauchon, professor of agricultural botany, both of Marseilles.

Mr. Otto Young has donated $100,000 to the endowment or building fund of the McCormick Memorial Institute for Infectious Diseases, Chicago.

Nature states that Mr. James Cosmo Melvill has presented his general herbarium to the Manchester Museum of the Victoria University. The herbarium has taken nearly forty years to collect, and it was formally opened in its new quarters by Sir W. T. Thistelton-Dyer, K.C.M.G., on October 31.

The teachers of mathematics in the Middle States and Maryland met at Princeton on November 28. Professor Gustave Legras of the College of the City of New York, who is chairman of the New York section of the Association, read a paper on 'Present Tendencies in the Teaching of Mathematics in Other Countries.'

The annual meeting of the Association of Mathematical Teachers in New England was held at Harvard University. William A. Francis of Exeter, N. H., was elected president, Professor Nathaniel F. Davis of Brown University vice president and Mr. George W. Evans of the English High School, Boston, secretary.

We learn from *Nature* that the inaugural meeting of the Association of Economic Biologists was held at Burlington House on Tuesday, November 8. Mr. F. V. Theobald occupied the chair, and in the course of his introductory remarks he detailed the steps taken by Mr. Walter E. Collinge to found the association. He hoped that the association would welcome all investigators in economic biology, whether agricultural, medical or commercial. The relationship between biology and agriculture was apparent to all, but only recently had the importance of its relationships with medicine and commerce been realized. Membership of the association will be confined to workers in economic biology. The following officers have been elected for 1904–5: *president,* Mr. Fred V. Theobald; *vice-president,* Mr. A. F. Shipley, F.R.S.; *council,* Professor G. S. Boulger, Professor A. H. R. Buller, Professor Geo. H. Carpenter, Dr. Francis Marshall, Mr. Robert Newstead, Major Ronald Ross, F.R.S., Mr. Fraser Storey, Mr. Cecil Warburton; *hon. treasurer,* Mr. Herbert Stone; *hon. secretary,* Mr. Walter E. Collinge. The next meeting will be held at Birmingham in April, 1905:

The forthcoming second edition of the German version of Mr. Balfour's presidential address to the British Association has brought, as we learn from the London *Times,* to the translator, Dr. M. Ernst, London correspondent of the *Neues Wiener Tagblatt,* the following letter from the Prime Minister:

10, Downing-street, Whitehall, S. W.,
Nov. 10, 1904.

My dear Sir:—I am much gratified to learn that there has been a sufficient demand for the German translation of my address to the British Association to make it worth while to issue a second edition; and all the more because the address touches on a middle region between physical science and philosophy, in which, as a rule, neither men of science nor philosophers are greatly interested.

At Cambridge, where the address was delivered, I had the honour of meeting some most distinguished German men of science, who took an im-

portant part in the various discussions with which the British Association busied itself. I would that the disinterested community of aim which thus binds together the scientific men throughout the world into one international brotherhood could extend its healing influence through all classes and all interests.

I remain yours faithfully,
ARTHUR JAMES BALFOUR.

THE Liverpool School of Tropical Medicine has, says the London *Times*, issued a series of reports on trypanosomiasis, that is to say, on the presence in the blood of man, and in the fluids of the brain and spinal cord, of some form of the microscopic parasite known as 'Trypanosoma,' which, having long been recognized as the cause of the virulent equine disease which is propagated by the tsetse fly in South Africa, has lately been discovered to be also the cause of 'sleeping sickness' in the human subject. The reports of Drs. Dutton, Todd and Christy have been sent home in instalments, some of which have already appeared in the medical journals. These and others are collected together in the present volume, which also contains an important note on the tsetse flies, by Mr. E. E. Austen, of the Zoological Department of the British Museum, and illustrations of flies and larvæ from the Congo. The details of cases given in the reports are, in a general way, too full of medical technicalities to be of general interest; but they seem to establish conclusively that 'sleeping sickness' is trypanosomiasis, although there are severe and even fatal cases of the latter in which the somnolence is not observed. The symptoms and the danger appear to bear some relation to the greater or less abundance of the parasites, and to become more marked and more serious when these have gained access to the cerebro-spinal fluid. The parasites may be present in the blood of deeply-seated organs when they are not discoverable in that which is drawn from a surface puncture; and their frequent temporary disappearances from surface blood render it sometimes difficult to be certain of their presence in the system. At the same time it appears that the term sleeping sickness is used very loosely among the Congo natives; and in many of the persons said to be suffering from it, and therefore brought to the hospital, the diagnosis was not confirmed either by the detection of the parasites or by the further progress of the case. One of the most curious results of the expedition has been the discovery of a bloodsucking larva of nocturnal habits, which seems to be abundant in many parts of the Congo, and which, during the daytime, seeks concealment in the cracks of the native floors, from which it may be dug out full of bright red blood as an evidence of the nature and the abundance of its previous night's meal. It is the larva of the *Glossina* fly, which appears to be harmless in the *imago* state, although it is probable that for this harmlessness the larva makes abundant compensation. The discovery will probably lead to the adoption of systematic measures for its destruction.

A REVIEW of the laws forbidding the pollution of inland waters in the United States has been prepared by Mr. Edwin B. Goddell for the United States Geological Survey. It is published as No. 103 of the series of Water-Supply and Irrigation papers. Mr. Goodell's purpose has not been to prepare a complete work on water pollution for the use of members of the bench and bar, but rather to put into the hands of public officials, legislators, water companies, manufacturers, farmers and others interested in the subject, a guide for their action, and to furnish references to the sources from which a more exhaustive knowledge of the subject may be obtained if required. No attempt has been made to present a detailed statement of the entire law against water pollution as it exists independently of statutes, but the broad legal principles under which antipollution statutes become operative are explained and important court decisions are quoted to show authority for various deductions. These principles and decisions have been classified and are presented in three groups: (1) The rights of riparian owners to pure water as against one another. (2) The rights of the public (as distinguished from individual owners) to have inland waters kept free from pollution by riparian owners or others. (3) The conditions under which, and the extent to which, public municipalities

may use inland waters in the disposal of sewage matter from public sewers. The statutes enacted in various states are classified according to their general scope and an opportunity is thus afforded to compare their effectiveness and desirability. In some states there is nothing more than a simple provision making it a crime to poison wells and springs, while in others elaborate provisions have been made to check and, so far as possible, absolutely prevent all pollution of all waters by the refuse products of animal life or the waste of human industry. In citing the statutes, Mr. Goodell has grouped the states together logically to show the stage of growth in sanitary education at which each has arrived. It is hoped that the publication and distribution of this paper will help to bring about a general apprehension of correct principles upon the important subject of water pollution.

UNIVERSITY AND EDUCATIONAL NEWS.

THE John Bell Scott Memorial Laboratory of Physical Science, at Wesleyan University, Middletown, Conn., will be dedicated on December 7. The address will be delivered by Dr. Edward B. Rosa, on 'The National Bureau of Standards and its Relations to Scientific and Technical Laboratories.'

WE learn from the London *Times* that at the beginning of last year an appeal was made by Dublin University for a fund for the development and better equipment of the science schools in Trinity College. Lord Iveagh offered to provide all the estimated building expenses (a sum of £34,000) conditionally upon the amount required for annual expenses being obtained by public subscription. For the latter purpose a capital of £78,000 is required. The committee in charge of the fund announce to-day that of this amount £15,886 has now been subscribed or promised, a site and designs have already been prepared for a new physical laboratory, and building operations will begin before the end of the year.

NEW medical buildings and the George Holt Physics Laboratory, which have been added to the Liverpool University, were opened on November 12. The inauguration proceedings took place in St. George's-hall and were presided over by the Chancellor of the University, Lord Derby, who was accompanied by Lord Kelvin, Mr. Haldane, K.C., M.P., Lord Cross and representatives of the English universities. The buildings have been erected at a cost of £21,600, which has been subscribed by Liverpool merchants and representatives of local families.

THE following promotions and appointments have been made in the Department of Mathematics and Astronomy of the University of Pennsylvania: George H. Hallett, Ph.D., has been promoted to an assistant professorship of mathematics; Eric Doolittle, C.E., to an assistant professorship of astronomy; Henry B. Evans, M.E., Ph.D., has been appointed assistant professor of mathematics.

DR. ALBERT WOELFEL has resigned his position in the Memorial Institute for Infectious diseases, Chicago, to accept an appointment in the Department of Physiology, of University of Chicago.

WE learn from *The Electrical World* that Professor Harry E. Clifford, acting head of the department of electrical engineering in the Massachusetts Institute of Technology, has been appointed to the free professorship of theoretical electricity in the institute. Mr. W. S. Barstow has been elected a member of the faculty of the Polytechnic Institute of Brooklyn. Mr. Barstow will serve in the department of electrical engineering as consulting professor of central station practice. Mr. Charles F. Scott has become a member of the board of consulting professors of the department of electrical engineering of the institute.

MR. R. P. GREGORY, demonstrator of botany, and Mr. E. Cunningham, senior wrangler, 1902, have been elected fellows of St. John's College, Cambridge.

PROFESSOR SVANTE ARRHENIUS, of Stockholm, has been called to the University of Berlin.

DR. W. NERNST, of Göttingen, has been called to Charlottenburg, as director of the Reichsanstalt.

DR. OTTO LUMMER, of the Reichanstalt, has been appointed professor of physics at the University of Breslau.

SCIENCE

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FRIDAY, DECEMBER 9, 1904.

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*THE RECENT DEVELOPMENT OF BIOLOGY.**

I.

THE task allotted to me on this occasion is a review of the development of biology during the last century. The limited time at our disposal will necessitate many omissions and will force me to confine myself to the discussion of a few of the departures in biology which have led or promise to lead to fertile discoveries.

The problem of a scientific investigator can always be reduced to two tasks; the first, to determine the independent variables of the phenomena which he has under investigation, and secondly, to find the formula which allows him to calculate the value of the function for every value of the variable. In physics and chemistry the independent variables are in many cases so evident that the investigation may begin directly with the quantitative determination of the relation between the change of the essential variable and the function. In biology, however, the variables, as a rule, can not be recognized so easily and a great part of the mental energy of the investigators must be spent in the search for these variables. To give an example, we know that in many eggs the development only begins after the entrance of a spermatozoon into the egg. The spermatozoon must produce some kind of a change in the egg, which is responsible for the development. But we do not know which variable in the egg is changed by the spermatozoon, whether the latter pro-

* Address delivered at the Congress of Arts and Science in St. Louis.

duces a chemical or an osmotic change, or whether it brings about a change of phase or some other effect. It goes without saying that a theory of sexual fertilization is impossible until the independent variable in the process of sexual fertilization is known.

But the investigations of the biologist differ from those of the chemist and physicist in that the biologist deals with the analysis of the mechanism of a special class of machines. Living organisms are chemical machines, made of essentially colloidal material which possess the peculiarity of developing, preserving and reproducing themselves automatically. The machines which have thus far been produced artificially lack the peculiarity of developing, growing, preserving and reproducing themselves, though no one can say with certainty that such machines might not one day be constructed artificially.

The specific and main work of the biologist will, therefore, be directed toward the analysis of the automatic mechanisms of development of self-preservation and reproduction.

II.

THE DYNAMICS OF THE CHEMICAL PROCESSES IN LIVING ORGANISMS.

The progress made by chemistry, especially physical chemistry, has definitely put an end to the idea that the chemistry of living matter is different from the chemistry of inanimate matter. The presence of catalyzers in all living tissues makes it intelligible that in spite of the comparatively low temperature at which life phenomena occur the reaction velocities for the essential processes in living organisms are comparatively high. It has been shown, moreover, that the action of the catalyzers found in living organisms can be imitated by certain metals or other inorganic catalyzers. We may, therefore, say that it is now proved beyond all doubt that the variables in the chemical processes in living organisms are identical with those with which the chemist has to deal in the laboratory. As a consequence of this result chemical biology has during the last years entered into the series of those sciences which are capable of predicting their results quantitatively. The application of the theory of chemical equilibrium to life phenomena has led biological chemists to look for reversible chemical processes in living organisms and the result is the discovery of the reversible enzyme actions, which we owe to A. C. Hill. I think it marks the beginning of a new epoch of the physiology of metabolism that we now know that the same enzymes not only accelerate the hydrolysis, but also in some cases, if not generally, the synthesis of the products of cleavage. It is not impossible that the results thus obtained in the field of biology will ultimately in return benefit chemistry, inasmuch as they may enable chemistry to accomplish syntheses with the help of enzymes found in living organisms which could otherwise not be so easily obtained.

A very beautiful example of the conquest of biological chemistry through chemical dynamics is offered by the work of Arrhenius and Madsen. These authors have successfully applied the laws of chemical equilibrium to toxins and anti-toxins so that it is possible to calculate the degree of saturation between toxins and anti-toxins for any concentration with the same ease and certainty as for any other chemical reaction.

We know as yet but little concerning the method by which enzymes produce their accelerating effects. It seems that the facts recently gathered speak in favor of the idea of intermediary reactions. According to this idea the catalyzers participate in the reaction, but form combinations that are again rapidly decom-

posed. This makes it intelligible that at the end of the reaction the enzymes and catalyzers are generally in the same condition as at the beginning of the reaction, and that a comparatively small quantity of the catalyzer is sufficient for the transformation of large quantities of the reacting substances.

This chapter should not be concluded without mentioning the discovery of zymase by Buchner. It had long been argued that only certain of the fermentative actions of yeast depended on the presence of enzymes which could be separated from the living cells, but that the alcoholic fermentation of sugar by yeast was inseparably linked together with the life of the cell. Buchner showed that the enzyme which accelerates the alcoholic fermentation of sugar can also be separated from the living cell, with this purely technical difference only, that it requires a much higher pressure to extract zymase than any other enzymes from the yeast cell.

III.

PHYSICAL STRUCTURE OF LIVING MATTER.

We have stated that living organisms are chemical machines whose framework is formed by colloidal material consisting of proteins, fatty compounds, and carbohydrates. These colloids possess physical qualities which are believed to play a great rôle in life phenomena. Among these qualities are the slow rate of diffusion, the existence of a double layer of electricity at the surface of the dissolved or suspended colloidal particles, and the production of definite structures when they are precipitated. We may consider it as probable that the cytological and histological structures of living matter will be reduced to the physical qualities of the colloids. But, inasmuch as the physics of the colloids is still in its beginning, we must not be surprised that the biological application of its results is still in the stage of mere suggestions. The most important result which has thus far been accomplished through the application of the physics of colloids to biology is Traube's invention of the semipermeable membranes. To Traube we owe the discovery that every living cell behaves as if it were surrounded with a surface film which does not possess equal permeability for water and the substances dissolved in it. Salts which are dissolved in water, as a rule, migrate much more slowly into the living cells than water. This discovery of the semi-permeability of the surface films of living protoplasm made, it possible to recognize the variable which determines the exchange of liquids between protoplasm and the liquid medium by which it is surrounded, namely, the osmotic pressure. Inasmuch as the osmotic pressure is measurable, this field of biology has entered upon a stage where every hypothesis can be tested exactly and biology is no longer compelled to carry a ballast of shallow phrases. We are now able to analyze quantitatively such functions as lymph formation and the secretion of glands.

Recent investigations have thrown some light on the nature of the conditions which seem to determine the semi-permeability of living matter. Quincke had already mentioned that a film of oil acts like a semipermeable membrane. From certain considerations of surface tension and surface energy it follows that every particle of protoplasm which is surrounded by a watery liquid must form an extremely thin film of oil at its surface. Overton has recently shown that of all dissolved substances those which possess a high solubility in fat, *e. g.*, alcohol, ether, chloroform, diffuse most easily into living cells. Overton concludes that lipoid substances such as lecithin and cholesterin which are found in every cell determine the phenom-

enon of the semi-permeability of living matter.

IV.

DEVELOPMENT AND HEREDITY.

We now come to the discussion of those phenomena which constitute the specific difference between living machines and the machines which we have thus far been able to make artificially. Living organisms show the phenomena of development. During the last century it was ascertained that the development of an animal egg, in general, does not occur until a spermatozoon has entered it, but, as already stated, we do not know which variable in the egg is changed by the spermatozoon. An attempt has been made to fill the gap by causing unfertilized eggs to develop with the aid of physicochemical means. The decisive variable by which such an artificial parthenogenesis can be best produced is the osmotic pressure. It has been possible to cause the unfertilized eggs of echinoderms, annelids and mollusks to develop into swimming larvæ by increasing transitorily the osmotic pressure of the surrounding solution. Even in vertebrates (the frog and petromyzon), Bataillon has succeeded in calling forth the first processes of development in this way. In other forms specific chemical influences cause the development, *e. g.*, in the eggs of star-fish diluted acids and, best of all, as Delage has shown, carbon dioxide. In the eggs of *Chætotopterus* potassium salts produce this result and in the case of *Amphitrite*, calcium salts.

From a sexual cell only a definite organism can arise whose properties can be predicted if we know from which organism the sexual cell originates. The foundations of the theory of heredity were laid by Gregory Mendel in his treatise on the 'Hybrids of Plants,' one of the most prominent papers ever published in biology. Mendel showed in his experiments that certain simple characteristics, as, for example, the round or angular shape of the seeds of peas or the color of their endosperm is already determined in the germ by definite determinants. He showed, moreover, that in the case of the hybridization of certain forms one half of the sexual cells of each child contains the determinants of the one parent, the other half contains the determinants of the other parent. In thus showing that the results of hybridization can be predicted numerically not only for one but for a series of generations, according to the laws of the calculus of probability, he gave not a hypothesis, but an exact theory of heredity. Mendel's experiments remained unnoticed until Hugo de Vries discovered the same facts anew, and at the same time became aware of Mendel's treatise.

The theory of heredity of Mendel and de Vries is in full harmony with the idea of evolution. The modern idea of evolution originated, as is well known, with Lamarck, and it is the great merit of Darwin to have revived this idea. It is, however, remarkable that none of the Darwinian authors seemed to consider it necessary that the transformation of species should be the object of direct observation. It is generally understood in the natural sciences either that direct observation should form the foundation of our conclusions or mathematical laws which are derived from direct observations. This rule was evidently considered superfluous by those writing on the hypothesis of evolution. Their scientific conscience was quieted by the assumption that processes like that of evolution could not be directly observed, as they occurred too slowly, and that for this reason indirect observations must suffice. I believe that this lack of direct observation explains the polemical character of this literature, for wherever we can base our conclusions upon direct observations

polemics become superfluous. It was, therefore, a decided progress when de Vries was able to show that the hereditary changes of forms, so-called 'mutations,' can be directly observed, at least in certain groups of organisms, and secondly, that these changes take place in harmony with the idea that for definite hereditary characteristics definite determinants, possibly in the form of chemical compounds, must be present in the sexual cells. It seems to me that the work of Mendel and de Vries and their successors marks the beginning of a real theory of heredity and evolution. If it is at all possible to produce new species artificially I think that the discoveries of Mendel and de Vries must be the starting point.

It is at present entirely unknown how it happens that in living organisms, as a rule, larger quantities of sexual cells begin to form at a definite period in their existence. Miescher attempted to solve this problem in his researches on the salmon. But it seems that Miescher laid too much emphasis upon a more secondary feature of this phenomenon, namely, that the sexual cells in the salmon apparently develop at the expense of the muscular substance of the animal. According to our present knowledge of the chemical dynamics of the animal body it seems rather immaterial whether the proteins and other constituents of the sexual cell come from the body of the animal or from the food taken up. The causes which determine the formation of large masses of sexual cells in an organism at a certain period of its existence are entirely unknown.

A little more progress has been made in regard to another problem which belongs to this group of phenomena, namely how it happens that in many species one individual forms sperm, the other eggs. It has been known for more than a century that it is possible to produce at desire either females exclusively or both sexes in plant lice. In bees and related forms, as a rule at least, only males originate from the unfertilized eggs; from the fertilized eggs only females. It is, moreover, known that in higher vertebrates those twins which originate from one egg have the same sex, while the sex of twins originating from different eggs may be different. All facts which are thus far known in regard to the determination of sex seem to indicate that the sex of the embryo is already determined in the unfertilized egg, or at least immediately after fertilization. I consider it possible that in regard to the determination of sex, just as in the case of artificial parthenogenesis, a general variable will be found by which we can determine whether an egg cell will assume male or female character.

V.

INSTINCT AND CONSCIOUSNESS.

The difference between our artificial machines and the living organisms appears, perhaps, most striking when we compare the many automatic devices by which the preservation of individuals and species is guaranteed. Where separate sexes exist we find automatic arrangements by which the sexual cells of the two sexes are brought together. Wherever the development of the eggs and larvæ occurs outside of the body of the mother or the nest we often find automatic mechanisms whereby the eggs are deposited in such places as contain food on which the young larva can exist and grow. We have to raise the question how far has the analysis of these automatic mechanisms been pushed. Metaphysics has supplied us with the terms 'instinct' and 'will' for these phenomena. We speak of instinct wherever an animal performs, without foresight of the ends, those acts by which the preservation of the individual or the species is secured. The term 'will' is reserved for those cases where these proc-

esses form constituents of consciousness. The words 'instinct' and 'will' do, however, not give us the variables by which we can analyze or control the mechanism of these actions. Scientific analysis has shown that the motions of animals which are directed towards a definite aim depend upon a mechanism which is essentially a function of the symmetrical structure and the symmetrical distribution of irritability. Symmetrical points of the surface of an animal, as a rule, have the same irritability, which means that, when stimulated equally, they produce the same quantity of motion. The points at the oral pole as a rule possess a qualitatively different or greater irritability than those at the aboral pole. If rays of light or current curves, or lines of diffusion or gravitation, start from one point and strike an organism, which is sensitive for the form of energy involved, on one side only, the tension of the symmetrical muscles or contractile elements does not remain the same on both sides of the body, and a tendency for rotation will result. This will continue until the symmetrical points of the animal are struck equally. As soon as this occurs there is no more reason why the animal should deviate to the right or left from the direction of its plane or axis of symmetry. These phenomena of automatic orientation of animals in a field of energy have been designated as tropisms. It has been possible to dissolve a series of mysterious instincts into cases of simple tropisms. The investigation of the various cases of tropism has shown their great variety and there can be no doubt that further researches will increase the variety of tropisms and tropism-like phenomena. I am inclined to believe that we possess in the tropisms and tropism-like mechanisms the independent variable of such functions as the instinctive selection of food and similar regulatory phenomena.

As far as the mechanism of consciousness is concerned no scientific fact has thus far been found that promises an unraveling of this mechanism in the near future. It may be said, however, that at least the nature of the biological problem here involved can be stated. From a scientific point of view we may say that what we call consciousness is the function of a definite machine which we will call the machine of associative memory. Whatever the nature of this machine in living beings may be, it has an essential feature in common with the phonograph, namely, that it is capable of reproducing impressions in the same chronological order in which they come to us. Even simultaneous impressions of a different physical character, such as, for instance, optical and acoustical, easily fuse in memory and form an inseparable complex. The mechanism upon which associative memory depends seems to be located, in higher vertebrates at least, in the cerebral hemispheres, as the experiments of Goltz have shown. The same author has shown, moreover, that one of the two hemispheres suffices for the efficiency of this mechanism and for the full action of consciousness. As far, however, as the physical or chemical character of the mechanism of memory is concerned, we possess only a few starting points. We know that the nerve cells are especially rich in fatty constituents and Overton and Hans Meyer have shown that substances which are easily soluble in fat also act as very powerful anesthetics, for instance, chloroform, ether and alcohol, and so on. It may be possible that the mechanism of associative memory depends in some way upon the constitution or action of the fatty compounds in our nerve cells. Another fact which may prove of importance is the observation made by Speck that if the partial pressure of oxygen in the air falls below one third of its normal value, mental

activity very soon becomes impaired and consciousness is lost. Undoubtedly the unraveling of the mechanism of associated memory is one of the greatest discoveries which biology has still in store.

VI.

ELEMENTARY PHYSIOLOGICAL PROCESSES.

It is, perhaps, possible that an advance in the analysis of the mechanism of memory will be made when we shall know more about the processes that occur in nerve cells in general. The most elementary mechanisms of self preservation in higher animals are the respiratory motions and the action of the heart. The impulse for the respiratory action starts from the nerve cells. As far as the impulses for the activity of the heart are concerned we can say that in one form at least they start from nerve cells, and in all cases from those regions where nerve cells are situated. But as far as the nature of these impulses is concerned we know as little about the cause of the rhythmical phenomena of respiration and heart beat as we know concerning the mechanism of associative memory. It is rather surprising, but nevertheless a fact, that physiology has not progressed beyond the stage of mere suggestions and hypotheses in the analysis of such elementary phenomena as nerve action, muscular contractility and cell division. Among the suggestions concerning the nature of contractility those seem most promising which take into consideration the phenomena of surface tension. The same lack of definite knowledge is found in regard to the changes in the sense organs which give rise to sensations. It is obvious that the most striking gaps in biology are found in that field of biology which has been cultivated by the physiologists. The reason for this is in part, that the analysis of the elementary protoplasmic processes is especially difficult, but I believe that there are other reasons. Medical physiologists have confined themselves to the study of a few organisms, and this has had the effect that for the last fifty years the same work has been repeated with slight modifications over and over again.

VII.

TECHNICAL BIOLOGY.

I think the creation of technical biology must be considered the most significant turn biology has taken during the last century. This turn is connected with a number of names, among which Liebig and Pasteur are the most prominent. Agriculture may be considered as an industry for the transformation of radiating into chemical energy. It was known for a long time that the green plants were able to build up, with the help of the light, the carbohydrates from the carbon dioxide of the air. Liebig showed that for the growth of the plant definite salts are necessary, that these salts are withdrawn from the soil by the plants, and that in order to produce crops these salts must be given back to the soil. One important point had not been cleared up by the work of Liebig, namely, the source of nitrates in the soil which the plants need for the manufacture of their proteins. This gap was filled by Hellriegel, who found that the tubercles of the leguminosæ, or rather the bacteria contained in these tubercles, are capable of transforming the inert nitrogen of the air into a form in which the plant can utilize it for the synthesis of its proteins. Winogradski subsequently discovered that not only the tubercle bacteria of leguminosæ are capable of fixing the nitrogen of the air in the soil in a form in which it can be utilized by the plant, but that the same can be done by certain other bacteria, for instance, *Chlostridium pasteurianum*. These facts have a bearing which goes beyond the interests of agriculture. The question of

obtaining nitrates from the nitrogen of the air is of importance also for chemical industry, and it is not impossible that chemists may one day utilize the experience obtained in nitrifying bacteria.

With the discovery of the culture of nitrifying bacteria we have already entered the field of Pasteur's work. Yeast had been used for the purposes of fermentation before Pasteur, but Pasteur freed this field of biology just as much from the influence of chance as Liebig did in the case of agriculture. The chemist Pasteur taught biologists how to discriminate between the useful and harmful forms of yeast and bacteria, and thus rendered it possible to put the industry of fermentation upon a safe basis.

In recent times the fact has often been mentioned that the coal fields will be exhausted sooner or later. If this is true every source of available energy which is neglected to-day may one day become of importance. Professor Hensen has recognized the importance of the surface of the ocean for the production of crops. The surface of the ocean is inhabited by endless masses of microscopic organisms which contain chlorophyl and which are capable of transforming the radiating energy of the sun into chemical energy.

Not only through the industry of fermentation and agriculture has technical biology asserted its place side by side with physical and chemical technology, but also in the conquest of new regions for civilization. As long as tropical countries are continually threatened by epidemics no steady industrial development is possible. Biology has begun to remove this danger. It is due to Koch if epidemics of cholera can be suppressed to-day and to Yersin if the spreading of plague can now be prevented. Theobald Smith discovered that the organisms of Texas fever are carried by a certain insect, and this discovery has had the effect of reducing and possibly in the near future destroying two dreaded diseases, namely, malaria and yellow fever.

It is natural that the rapid development of technical biology has reacted beneficially upon the development of theoretical biology. Just as physics and chemistry are receiving steadily new impulses from technology, the same is true for biology. The working out of the problems of immunity has created new fields for theoretical biology. Ehrlich has shown that in the case of immunity toxins are rendered harmless by their being bound by certain bodies, the so-called anti-toxins. The investigation of the nature and the origin of toxins in the case of acquired immunity is a new problem which technical biology has given to theoretical biology. The same may be said in regard to the experiments of Pfeifer and Bordet on bacteriolysis and hemolysis. Bordet's work has led to the development of methods which have been utilized for the determination of the blood relationship of animals.

VIII.

The representatives of the mental sciences often reproach the natural sciences that the latter only develop the material but not the mental or moral interests of humanity. It seems to me, however, that this statement is wrong. The struggle against superstition is entirely carried on by the natural sciences, and especially by the applied sciences. The nature of superstition consists in a gross misunderstanding of the causes of natural phenomena. I have not gained the impression that the mental sciences have been able to reduce the amount of superstition. Lourdes and Mecca are in no danger from the side of the representatives of the mental sciences, but only from the side of scientific medicine. Superstition disappears so slowly for the reason that the masses as a rule are not taught any sciences. If the day comes

when the chief laws of physics, chemistry and experimental biology are generally and adequately taught we may hope to see superstition and all its consequences disappear, but not before this.

As far as the influence of the applied sciences on ethics is concerned, I think we may hope that through the natural sciences the ethics of our political and economical life will be altered. In our political as well as our economical life we are still under the influence of the ancients, especially the Romans, who knew only one means of acquiring wealth, namely by dispossessing others of it. The natural sciences have shown that there is another and more effective way of acquiring wealth, namely, by creating it. The way of doing this consists in the invention of means by which the store of energy present in nature can be more fully utilized. The wealth of modern nations, of Germany and France, is not due to their statesmen or to their wars, but to the accomplishments of the scientists. It has been calculated that the inventions of Pasteur alone added a billion francs a year to the wealth of France. In the light of such facts it seems preposterous that statesmen should continue to instigate war simply for the conquest of territories. Through modern science the wealth of a nation can be increased much more quickly than through any territorial conquest. We can not expect any change in the political and economical ethics of nations until it is recognized that the lawmakers and statesmen must have a scientific training. If our lawmakers possessed such a training they would certainly not have allowed one general source of energy after another, such as oil fields, coal fields, water power, etc., to be appropriated by individuals. All these stores of energy belong just as well to the community as the oxygen of the air or the radiating energy of the sun. Our present economical and political ethics is still on the whole that of the classical period or the renaissance, because the knowledge of science among the masses and statesmen is still on that level, but the natural sciences will ultimately bring about as thorough a revolution in ethics as they have brought about in our material life.

IX.

If we compare the development of biology with the simultaneous development of physics and chemistry during the last twenty years, we must be impressed by the fact that during that time the great discoveries in physics and chemistry have followed each other surprisingly fast. The discovery of the law of osmotic pressure, the theory of electrical disassociation, the theory of galvanic batteries, the systematic formulation of physical chemistry, the discovery of electrical waves, the discovery of the X-rays, the discovery of the new elements in the air, the discovery of radioactivity, the transformation of radium into helium, the theory of radiation pressure—what have we in biology that could be compared with such a series of discoveries? But I believe that biology has important discoveries in store and that there is no intrinsic reason why it should be less fertile than physics and chemistry. I think the difference in the fertility of biology and the physical sciences is at least partly due to the present organization of the biological sciences.

General or experimental biology should be represented in our universities by special chairs and laboratories. It should be the task of this science to analyze and control those phenomena which are specifically characteristic of living organisms, namely, development, self preservation, and reproduction. The methods of general biology must be those of chemistry and especially those of physical chemistry. To-day general or experimental biology is represented

in our universities neither by chairs nor by laboratories. We have laboratories for physiology, but to show how little interest physiologists take in general biology I may mention the fact that the editor of a physiological annual review excludes papers on the development and fertilization from his report, as in his opinion, this belongs to anatomy. On the other hand, anatomists and zoologists must give their full energy to their morphological investigations and have, as a rule, neither the time for experimental work nor very often the training necessary for that kind of work. Only the botanists have kept up their interest in general biology, but they of course pay no attention to animal biology. In working out this short review of the development of biology during the last century I have been impressed with the necessity of our making better provisions for that side of biology where, in my opinion, the chances for the great discoveries seem to lie, namely, *general* or *experimental* biology. JACQUES LOEB.

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*THE PROBLEMS OF EXPERIMENTAL PSYCHOLOGY.**

THE first difficulty that confronts one, as one attempts to envisage the problems of experimental psychology, is the difficulty of definition. What is a psychological experiment? What is the scope of experimental psychology? Is experiment simply a method of work, applicable to all or to some special parts of the psychological system; or is experimental psychology a distinct branch of psychology, sharply marked off from other and coordinate branches?

The program of this congress would seem to have decided the issue in the latter sense; for we find sections of general psychology, of comparative and genetic psychology, of abnormal psychology and of social psychology, arranged alongside of our own section of experimental psychology. If, then, I wished to take shelter behind the plan of the program, I might, with some show of justification, confine myself to the discussion of those problems in normal, human, adult psychology which still form the staple material of experimental investigation in the laboratories, and might omit all reference to the extensions of the experimental method to outlying fields. Such a course would, nevertheless, be unsatisfactory. The extensions of the method are coming to play a larger and larger part in psychological discussions and in our psychological literature; and it behooves us to take up a stand with regard to them, positive or negative, appreciative or critical. I shall try not to shirk this duty. Let me say, however, at the outset —and I shall have more to say upon the matter presently—that, whatever else experimental psychology may be, there can be no doubt that the subjects to which the program apparently limits us are experimental psychology. The examination, under strictly controlled and properly varied conditions, of the normal, adult, human mind—this is psychological experiment in its pure, primary and typical form. And it is this typical experimental psychology the problems of which we have, in the first place, to consider.

In approaching this question of the problems of experimental psychology, it seemed to me that the surest key to the future lay in the accomplishment of the past. The best way to find out what experimental psychology has to do is, I thought, to make certain of what it has already done. With this idea in mind, I naturally had recourse to our bibliographies—the American bibliography of the *Psychological Review*, and the German of the *Zeitschrift f. Psychologie*. The result was not encouraging. We

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all knew, of course, that the plan of arrangement of these two yearly lists is by no means the same. What I, for one, had not realized was the fact that the plan of arrangement of both is eminently unsystematic. We use a bibliography, and find it useful; we do not need to enquire further regarding it. But I do not believe that any psychologist, of whatever school, could write a systematic psychology on the lines laid down in these bibliographies. This fact—if fact it is—seems worthy of a passing remark; for it indicates, in a concrete and definite way, that in spite of the enormous increase of our psychological knowledge, within the last few decades, we are still very far from any complete or rounded science of psychology. I am not so much disposed to blame the bibliographers—I take their lack of system to be unavoidable—as I am to draw a long breath at the amount of work which still remains for us to do.

Finding that I could not avail myself of the bibliographies, I took the bull by the horns, and went to the psychological journals. I listed and analyzed the experimental papers in the *Philosophische Studien,* the *Zeitschrift f. Psychologie,* the *Année psychologique,* the *American Journal of Psychology* and the *Psychological Review;* not with any view of substituting a classification of my own for the classifications now employed, but simply with the intention of finding out what was there. If you object that these five journals are not coextensive with experimental psychology, I must reply that they are at any rate representative, and that the duration of human life is limited. Even so, I am not sure that the game was worth the candle. I earned, perhaps, by hard work, the right to stand upon this platform; but I found out very little that I did not know before.

If I am to indicate, briefly, the results of this enquiry, I must premise that we are agreed upon the distinction, within experimental psychology, between the properly 'psychological' and the psychophysical attitudes. The object of the 'psychological' experiment, as I am now using the phrase, is introspective acquaintance with the processes and formations of a given consciousness. The object of the psychophysical experiment, as we have recently been reminded by G. E. Müller—I suppose that we are all fresh from a reading of his 'Psychophysische Methodik'—is a numerical determination. Thus, the object of the simple reaction, regarded as a psychological experiment, is the introspective analysis of the action consciousness, given under certain fixed conditions; the object of the same experiment, regarded psychophysically, is the ascertainment of a representative time-value and of the manner and limits of its variation. Both points of view are covered by the general term 'experimental psychology'; both types of experiment are valuable; but the two must not be confused. If, now, we look at the contents of the *Philosophische Studien,* the oldest established of our five journals, we find that three departments of experimental investigation are preferred high above the rest: sensation, perception and action. There is, moreover, a very definite trend towards psychophysics, so that, *e. g.,* at least two fifths of the articles that deal with sensation must be classed outright as psychophysical. The remaining experimental papers may be subsumed under the headings: association of ideas, attention, feeling, memory and recognition, the organic accompaniments of the mental life, the range of consciousness, the processes involved in the activities of reading and writing, and the time consciousness. What we find in the other four journals is a continuance of interest in these same problems, but a continuance of interest which is combined with a shift of emphasis from psycho-

physics to psychology, and a widening of the area of experimental work. Thus in the *Studien* there are about twice as many articles on sensation, psychological and psychophysical, as there are on perception; in the *American Journal,* the articles on perception are more numerous than those on sensation; in the *Psychological Review* there are, roughly, three articles on perception for every two on sensation, while the strictly psychophysical papers may almost be counted upon the fingers of one hand; and the *Année psychologique,* if I have counted aright, has practically as many articles on memory as it has on perception, and more of either than it has on sensation, while the spirit of the work has, from the first, been adverse to psychophysics. Or again, the contents of the *American Journal* may, with some manipulation, be brought under the same headings that served for the *Studien,* save that one additional caption must be made for studies of voluntary movement (other than reactions) and of the experiences of effort and fatigue; while those of the *Zeitschrift* and the *Psychological Review* require at any rate three or four new rubrics, to cover work done upon mental inhibitions, the process of learning, motor automatisms and motor dispositions, habit, etc. I do not wish to labor this point, even if I must leave it with some sense of injustice to the periodicals under review. You know, without my telling you, and I knew, without going to the magazines, that the course of experimental psychology in recent years has been away from simple psychophysical determinations, and towards introspective analysis; and that the experimental method has been continually extended from the simpler processes to the more complex—whether to complexes hitherto untouched by experiment, or to unfamiliar phases of familiar mental formations. All that a study of the journals can do is to quantify and define these facts. I should like to add, however, that their study has brought home to me, in a very vivid way, the immense complexity and far-reaching interconnection of the mental life. The contents of experimental papers are oftentimes so varied that only a classification *a posteriori* is possible; and, oftentimes again, results that are but incidental to the given topic of investigation prove later on to be fundamental for problems from which this topic had seemed disconnected and remote.

So much, then, by way of preparation. Let us now, in the light of it, attempt to formulate the present problems of experimental psychology. You will remember that I am speaking of experimental psychology *sensu stricto*—of the experimental investigation of the normal, adult, human consciousness. I wish that I could proceed systematically. But, in the existing condition of the science, it is better to be topical. We may, however, begin in a quasi-systematic way, by considering the three fundamental problems of sensation, affection and attention.

(1) *Sensation.*—The senses, viewed from the standpoint of psychological knowledge, fall into three principal groups. We know a great deal about sight and hearing; we know a good deal about taste, smell and the cutaneous senses; of the organic sensations, with a very few exceptions, we know practically nothing. There is work to be done—I say this emphatically—in every field; there is probably no single chapter in sense psychology that may not, with advantage, be reopened. Nevertheless, we know a great deal about sight and hearing; the literature of these senses is voluminous; advance in our knowledge lies (I am speaking in the large and quite roughly) in the hands of the few experts who have occupied themselves particularly with visual and auditory problems. And we know a good deal about taste, smell and the cuta-

neous senses; although here, doubtless, there is much steady work, rank and file work, yet to be done. We know something of the organic complex concerned in active touch, and something of the static sense. On the other hand, of the organic sensations in general we know practically nothing. Here then, as I take it, lies the immediate sense problem for experimental psychology. When we remember the importance of organic sensation in the affective life, its importance as the vehicle of sensory judgments in psychophysical work, the part it plays in the mechanism of memory and recognition or in the motives to action, its importance for the primary perception of self; when we remember the widespread character of the organic reaction set up by any sensory stimulus; when we realize that some psychological systems have recourse to it from beginning to end, while others (Wundt's recent 'Grundzüge' is an example) practically ignore it; when we remember that certain questions of prime systematic importance hinge upon it—the question of the duality of the conscious elements, of the relative range of sensation and image, of what is called affective memory, and so on: we can hardly fail to see that here is a great gap in our psychological knowledge, the filling of which calls for a persistent application of the experimental method. Of all problems in the psychology of sense that are now before us, the problem of the number, nature and laws of connection of the organic sensations appears to me to be the most pressing.

In the domain of psychophysics, I see no single problem of supreme import, but rather a need for patient, continuous work by the methods already formulated. The inherent aim of psychophysical investigation is, as I have said, the determination of the psychophysical constants. Now it is by no means difficult to vary a psychophysical method, and so to set up a claim of originality; but it requires patience and some self-sacrifice to work through a psychophysical method to the bitter end. What we now want is less ingenuity and more work—accurate, continuous work all along the line. We have methods and we have formulæ. Let us give them a thorough test. The results will be of extreme value for psychophysics, and no one need fear that they will be barren for psychology. On the contrary, no small part of our analytical knowledge of the higher processes, as they are called—processes of judgment, of comparison, of abstraction—derives straight from the method-work of psychophysics. It would, in my opinion, be time and energy well spent, if every existing laboratory were to undertake what one might term the routine work of testing out, without modification, one or other of the classical methods.

I am aware that psychophysics trenches upon large problems. I ought, indeed, to be keenly alive to these problems, seeing that for the past three years they have occupied me, with but little intermission. There is the great problem of mental measurement itself; there are the minor problems of the validity of the difference limen, the equality of just noticeable differences, the range of Weber's Law, the correlation of functional constants, and what not. If I were speaking of the history of experimental psychology, and not of its present status, I might hope to show you that more has been done towards a solution of these problems than the current statements in text-books and magazines would lead one to suppose. But, with these problems in mind, I insist that the immediate demand in psychophysics is for careful, straightforward work by the approved methods. We shall gain more from such work than from anything else.

(2) *Affection.*—When we turn to the af-

fective processes, we have no such difficulty in selecting our problems. This whole chapter in experimental psychology is one single problem. Will you believe—I had myself not realized it before—that in all the five and thirty volumes of the *Zeitschrift* there is not a solitary experimental article on the feelings? This although the same volumes contain, roughly, two hundred contributions to experimental psychology! The *Studien* has about one hundred and forty experimental papers, of which nine deal with affective psychology or experimental æsthetics: that is the best record I have found. Now look at the problems. We are not at one as regards the nature and number of the elementary affections; there are experimental psychologists who reduce all the elements of consciousness to sensations. We are not agreed whether the diversity of feelings is to be referred to a diversity of affective process proper or to a diversity of organic sensation. Some of us think that a given affective process is coextensive with consciousness; others maintain that consciousness may be a mosaic of affections. Some assert that the feeling element is effective for association; others deny it this effectiveness. Some find the best illustrations of the law of contrast in the sphere of feeling; to others, contrast may itself be a feeling. Our facts are few, our laws dubious. Surely, it is time to gird up our loins and make serious business of these affective problems.

I have insisted on the paucity of the experimental articles upon feeling. I do not, by this, mean to accuse experimental psychology of idleness or neglect: Lehmann's two books would save us from such a charge, if we had nothing else to offer. But these two books are characterized by their reliance upon the expressive method —a method which, as you are aware, has stood in the forefront of many recent discussions. I have been at the pains to make out a complete table—complete, that is, so far as I was able to make it complete—of the results obtained by the method of expression. There is much to be learned from them. But I can not believe that the method will help us very greatly towards an affective psychology. The organic reactions which the expressive method registers are closely interwoven and interdependent, and the task of differentiation presents difficulties which, if not insurmountable, have at least not yet been surmounted. I am disposed to think, *e. g.*, that the plethysmograph, as a differential instrument, is doomed to disappear from our laboratories. The sphygmograph, and especially the pneumograph, hold out better hope; but I doubt if, at the best, a differentiation of affective qualities is to be expected from them. From the method of suggestion, which really takes us over into social psychology, I expect still less. There remains, at present, only the method of impression, which has done good service in a limited field, and which should be capable of modification and expansion. However, I am fortunately not called upon here to propose methods of work, but only to indicate problems. And the facts and laws of the affective life, the life of feeling and emotion, form one of the largest and one of the most insistent problems of modern experimental psychology.

(3) *Attention.*—The prominence given to the state of attention is characteristic of experimental psychology, as contrasted with the empirical psychology of associationism. It is, indeed, one of Wundt's greatest services to the new psychology that he early divined the cardinal importance of attention in the psychological system, and began that series of experiments of which we can by no means see the end to-day. For I imagine that we must all admit, if we are honest with ourselves, that the body of

facts at our disposal, large and varied as it is, is yet not adequate to a theory of the attentive state. We must know more of the constitution of the attentive consciousness, and of the mechanism of distraction; much remains to be done before we can settle the vexed questions of the distribution of attention; we must work out, experimentally, the relation of attention to affective process; even the familiar problems of the range and duration of the attentive state are—well, are still problems. I am not sure that we shall not have to manifold the study of attention, as we have that of memory; and to speak in future of the facts and laws of visual attention, auditory attention, and so on, instead of taking 'attention' as a single state. I am certain that we must have a more specialized psychology of the great variants and resultants of attention—a specialized psychology of expectation and habituation, of practise and fatigue.

If, then, I have seized the situation correctly, we have in these three fundamental departments of psychology three problems of different orders, the solution of which calls for a diverse endowment of psychological skill and insight. There is an outlying group of sensations that can, we must believe, be successfully attacked by the analytic methods which have been successfully employed in the other sense departments. The experimental study of the affective processes calls for a much greater gift of originality and constructive imagination; we have to shake off literature and tradition, and to begin almost at the beginning. In the case of attention, we have to push on and make progress along paths already marked out but insufficiently explored.

What holds in this regard of the attention seems to me to hold also (4) for that mixed medley of formations which we include under the general term *perception*. I wish that we could banish the word 'perception' to the special limbo reserved for unregenerate concepts, and could put in its place a round dozen of concrete and descriptive terms! But it has, so far, held its own, and I can hardly avoid its use. We know, now, a great deal about tonal fusion, about space perception, about rhythm—if rhythm be a perception; we know something about time perception. You will, however, agree with me that no one of these topics is a closed chapter. I see no very pressing problem, as I look over the field; but I see, in every quarter of it, good work that needs doing. I am sorry if this opinion appears indefinite; it is the opinion that I have come to after a study of more than a hundred and fifty articles that deal with perception in the five journals referred to just now: and I can not make it more definite without going so deeply into detail as far to exceed the time allotted to me.

We can speak a little more concretely of (5) *recognition, memory* and *association*. Association was, at first, handled in rather stepmotherly fashion by experimental psychology. Of late years, however, we have come to see the importance of detailed analyses of the associative, as also of the recognitive consciousness; we have, I think, finally broken free from the traditional schemata, and are approaching the problem with open minds. Something has already been done; much more remains to do. The experimental study of memory was begun, by Ebbinghaus, rather in a practical or psychophysical than in a psychological spirit. In the development of the work since Ebbinghaus, we can trace two tendencies: a tendency towards psychological analysis of the memory consciousness and the explication of the psychological laws of memory: that on the one hand; and on the other, a tendency towards the application in practise of psy-

chological results. While, now, I take the recent experimental work on memory and the associations involved in memory to be work of a high order; and while I believe, in particular, that certain of the methods employed are a valuable addition to our psychological repertory, I can not but think that the two tendencies just mentioned have not been kept as distinct as they should have been, and that experimental psychology has suffered in consequence. We can hardly hope to get a psychology of memory and association on the ground of Reproduktionstendenz and Perseverationstendenz: we can hardly hope to get practical rules, if they are what we want, out of the published studies on economy of learning. The Tendenz-concepts are psychophysical, and tend to cover up the complexity of actual experience; the practical studies are made under conditions widely remote from those that obtain in ordinary practise. Let us realize that we may attempt here any one of three distinct problems. We may aim at a psychology of memory and association; *i. e.*, we may seek to record our experience, to trace the introspective patterning of the memory consciousness. We may aim at a psychophysics of memory; *i. e.*, we may try to establish formulæ akin to the well-known formula of Ebbinghaus' 'Gedächtnis,' which represents retention as a function of time elapsed. Or we may aim at an applied psychology of memory; we may work out, experimentally, an art of acquisition. I do not say that an investigation into one of these three topics will throw no light on the other two; on the contrary, I have already insisted on the value of indirect results in psychological enquiries. But in our thought, at any rate, the three problems should remain separate and distinct. They offer, without doubt, a wide field for future research. I would suggest, though with all reserve, that the psychological study of memory and association may, in the long run, help us to clear up the much-disputed question of the subconscious. There are, as you know, experimental psychologists who work simply in terms of introspection and of physiological process; there are others who interpolate between these terms an unconscious or subconscious mentality. I can not go into detail; but it seems to me that, if these differences of opinion can in any connection be brought into the laboratory for adjustment, it is here, in the investigation of memory and association, that we may hope to introduce them.

I come next (6) to *action*. You will remember that, in its early years, experimental psychology was much concerned with the psychophysics of action; indeed, the problem of the 'personal equation' is a good deal older than our laboratories. This interest has never flagged. If we have not heard so much of late about reaction experiments, we have heard a great deal about the psychophysiology and psychophysics of voluntary movement. And I think that we can leave those things to take care of themselves; we may, without any question, look to the next few years for improvements of technique, for revision of numerical determinations, for recasting of theories. That work is under way. What I should like now to emphasize is the need for investigation of the more strictly psychological kind. Our knowledge of the action consciousness is still very schematic, very rough, in part very hypothetical. It has been recognized for some years that the reaction experiment may be turned to qualitative, *i. e.*, to analytical account; but so far more use has been made of this idea in laboratory practise than in research. We must start all over again, and take the action consciousness seriously. I once made a sort of reaction experiment of the setting-up and

taking-down of an inductorium; the student made the manipulations continuously, under time control, and gave his introspective record at the end of each experiment. We worked at the problem for a year, only to learn that we had been too ambitious; we had, as even with experience one is apt to do, underestimated the complexity of consciousness. At the same time, we decided that the problem was soluble; we gathered in a good store of introspective results, even if they were too individual, and too discrete, to be employed for generalization; with more time and more observers, or with a simpler set of voluntary movements for study, we should have accomplished something for psychology. I regard such studies as those recently made on the control of the retrahens of the ear, or on the control of the winking reflex, as extremely promising in this field. At any rate, whether we work from the classical reaction experiment, or whether we take voluntary movement under more natural conditions, the problem is quite definite: we must submit action to an introspective analysis as detailed and as searching as that to which we have subjected perception.

I have put off (7) *imagination,* because I am a little afraid of the term. It is a word which, like perception, I should be glad to see discarded from the vocabulary of experimental psychology. I think that we employ it more vaguely even than we employ perception; and I think that the future will substitute for it a number of descriptive terms. If we begin with the elementary process, the image itself, we must plead ignorance on two fundamental points: whether image quality is coextensive with sensation quality, and whether image difference is adequate to sense discrimination. If we go to the other extreme, and regard imagination as the general name for a group of typical formations—as a concept coordinate with memory—we must surely say that experimental psychology is, as yet, hardly over the threshold of the subject. We know, perhaps, how to set to work: some investigations have been made, and some hints toward method have been given; but, in the large, this chapter of experimental psychology remains to be written.

(8) Of the more complex *affective* formations we can say but little until we have a better psychology of feeling. No doubt, there are certain problems in the psychology of sentiment, and more especially in that of the esthetic sentiments, that can, within limits, be handled without regard to the ultimate categories of feeling. I should, however, consider these limits as very strictly drawn. (9) For the higher *intellectual* processes we have, I think, three sources of knowledge: direct experiment—that, as you know, has been well begun,—the indirect results of experiment upon sensation, and Völkerpsychologie. I am inclined to lay great stress upon the second of these sources. Experimental psychology has often been reproached, on the one hand, because it devotes most of its time to sensation, and on the other because the results of its dealings with the higher processes are jejune and meager. To the former charge I plead guilty, in so far as we have avoided the affective problems, though this neglect is not at all what the framers of the accusation have in mind. And even so, I might offer in extenuation the experimental work upon attention. But this apart, I think that experimental psychology is justified in its choice of topics. The only way to catch the higher intellectual processes in course of formation is to work from the periphery, by way of the sense organs. It is when we are working with tones, or with lifted weights, that the amazing diversity and complexity of judgment becomes apparent. If, on the con-

trary, we take any one of these higher processes full-formed, and attack it directly, we are very likely to find that the vehicle of the mental function is extremely simple; there is a law of reduction, running all through mind, whereby a highly complex formation tends to degenerate, to reduce to a stereotyped simplicity. It is, to my mind, a distinct merit of experimental psychology that it has brought to light this meagerness of content in the examination of 'higher' mental functions of an habitual order; and it is a healthy instinct that sends us back and back again to the channels of sense, as we seek an appreciation of the fulness and richness of the mental life. I may add, though I say this a little hesitatingly, as a merely personal impression, that the introspective attitude of the observer seems to me to be more nearly normal, less artificial, in cases where the avowed object of experimentation is comparatively simple. If you are asked overtly to grapple with a complex psychosis, you are likely to brace yourself to the task, to put on an armor of preconceived opinion; if the psychosis meets you unawares, finds you off guard, the facts will have their own way with you. A distinguished English psychologist once declared that it is futile to attempt the problems of recognition by way of rotating discs of black and white sectors. I should say, on the contrary, that these discs are, in principle, the very best means to an understanding of the higher intellectual formations.

As for the ultimate goal of experimental endeavor, I suppose that we may call it (10) the problem of *consciousness*,—not in the sense in which that problem is understood by the theorist of knowledge, but in this sense: that, as hitherto we have analyzed and traced to their conditions certain mental processes, of lesser or higher degrees of complication, so now we analyze and trace to their conditions total consciousness, given in varying states and constituted of various formations. The difficulty of this problem is enormous. Only those of you who have attempted it, in one case or other, for yourselves, who have discarded classificatory terms, and faced the living facts; only these, even of experimental psychologists by profession and training, can form any proper idea of its difficulty. It is a problem for which we are not yet ripe. We can approach it only by way of theories which we know to be inadequate, and by help of hypotheses which we can not substantiate by facts. But it is the problem towards which we are trending, and the road to its solution lies, as in my judgment all such roads in our science lie, not through brilliant suggestion and ingenious forecast, but through patient and steady work. This work must be in part the work of experimental psychology, as we are here interpreting that phrase; in part the work of what is called individual psychology—though, indeed, from perception onwards, the difference between these two departments of psychological investigation is simply a difference of accent. Or, to put the matter concretely, we must work not only with the doctrine of states of consciousness, comparing experimentally the attentive and the inattentive, the hypnotic and the dreaming, all sorts of normal and abnormal states of consciousness, but also with the doctrine of conscious types which we owe (and the debt is great) to the psychologists of individual variation.

So I finish the first part of my review. If I have omitted anything of consequence, or if I have seemed to do injustice to any department of work, I must ask for pardon and correction; I have spoken with the utmost possible brevity. My own habitual thought in experimental psychology is positive, not negative; that is, I am accustomed to look upon our problems rather as con-

tinuations of work already begun than as gaps and lacunæ in our system of knowledge. I could wish that it had fallen to my lot to address you in this positive way, to show what experimental psychology has done, how in the past few decades it has changed the face of systematic psychology, rather than to insist upon the tasks that still lie before it. I have, however, tried to be entirely honest; I have, I think, rather exaggerated than concealed our deficiencies; and I would have you remember that this definite formulation of things to do presupposes and implies that much has been done. When Wundt wrote his famous essay 'Ueber die Aufgaben der experimentellen Psychologie,' the problems that loomed before him were the psychophysics of sensation, the analysis of perception, the time-relations of the higher processes. To-day, the list is longer and the range wider. But it is only because we already possess that we can say, in such detail, what still needs to be added to our possessions: in which fact let us take encouragement.

I pass, with some diffidence, to a consideration of wider issues—of those extensions of the experimental method, proposed or attempted, of which I spoke at the beginning of this address. Most psychologists, I take it, would agree that the picture I have drawn of experimental psychology in what has preceded is drawn too narrowly. The title of psychologist is, indeed, given at the present day to two distinct types of scholar. On the one hand, we have the psychologist as I have represented him: a man keenly interested in mind, with no purpose beyond mind; a man enamored of introspection; a man to whom the most fascinating thing in the universe is the human consciousness; a man to whom successful analysis of an unresolved mental complex is as the discovery of a new genus to the zoologist or a new river to the explorer; a man who lives in direct companionship with his mental processes as the naturalist lives with the creatures that are ordinarily shunned or ignored; a man to whom the facts and laws of mind are, if I may so put it, the most real things that the world can show. On the other hand, we have men to whom mind appeals either as a datum or problem, or both, to be dealt with by philosophy, by theory of knowledge and theory of being; or as a natural phenomenon, something that must be taken account of whenever life is taken account of, in evolutionary biology, in anthropology, in medicine, and where not. Of the psychologists of this second order, the philosophers, you will say, do not concern us. Yet they do, somewhat. I suppose that all sciences—certainly, all young sciences—are liable to be told by well-wishers that they have mistaken their work; that they would advance more quickly, and more solidly, if they would put off their present business, and settle down to this or that suggested problem. At any rate, experimental psychology has always received such hortation from friendly philosophers. If, now, I have ignored this advice, it is not from lack of gratitude, but simply because, after consideration, I have come to believe that experimental psychology knows what she is about, and can walk without assistance. Outsiders, we are told, see most of the game. I venture to urge that the insider better knows how the game is to be played.

We are left with the two opposed types: what shall I term them?—the inner and the outer, the subjective and the objective, the narrower and the broader. What, then, of the outer, wider, objective problems of experimental psychology?

Let us be clear, first of all—the matter admits of no hesitation or compromise—that the experimental psychology of the normal, adult, human mind must take the

form that I have described—the form of introspective analysis. I have little sympathy or patience with those experimentalists who would build up an experimental psychology out of psychophysics and logic; who throw stimuli into the organism, take reactions out, and then, from some change in the nature of the reactions, *infer* the fact of a change in consciousness. Why in the world should one argue and infer, when consciousness itself is there, always there, waiting to be interrogated? This is but a penny-in-the-slot sort of science. Compared with introspective psychology, it is quick, it is easy, it is often showy. We have been a little bit corrupted by the early interest in psychophysics; or perhaps, more truly, we have not all learned instinctively to distinguish between psychophysics and psychology proper; and so we are apt to take the tables and curves of reactions for psychological results, and the inferences from them for psychological laws. Now the results, where they are not purely physiological or anthropometrical, are psychophysical results. As such, they have their usefulness; and the psychological laboratory is their right place of origin. But there is no reason why one should gain psychological credit for them —still less for erecting a speculative psychology upon their foundation. This mode of psychologizing is inherently as vicious as any of the constructive modes of the older psychology, the psychology before experiment. Historically, it has proved disastrous;* it falsifies problems and obscures real issues; we must set our faces against it now and for all time. How, indeed, shall one call a man a psychologist who deliberately turns his back upon the one psychological method, in the one field to which that method directly applies? There is no excuse, in psychology, for the neglect of introspection, save the one—and that must be demonstrated—that introspection is impossible.

Having said this much by way of preface, I may take up the further question. We can hardly open a magazine nowadays without finding applications of the experimental method beyond the limits of the normal, adult, human mind. In animal psychology, in child psychology, in various departments of mental pathology, the experimental method is employed. Even the conservative *Studien* contains articles on the state of sleep and dreaming, and Wundt has looked more favorably upon experiments under hypnosis since they promise to confirm his theory of feeling. Experiments on children and animals have for some years past occupied the attention of leading American psychologists; work on child psychology is characteristic of the *Année psychologique,* and is being published more and more freely by the *Zeitschrift;* you all know the avowed purpose of Kraepelin's 'Arbeiten.' I need not multiply references. Wherever psychological interest has gone, in these fields, the experimental method has gone with it. Sometimes the particular experiment is borrowed forthright from the normal practise of the laboratory, sometimes the procedure has been recast to suit the novel problem; sometimes the experimental method is taken seriously, employed with care and knowledge, sometimes it is thrown in as a makeweight, without responsibility or understanding; sometimes it is praised, sometimes decried. All this is natural. The important thing for us is, I think, the recognition that the experiments are a part of 'experimental psychology,' in the sense of this paper, and must be taken account of in any general review

* Is proof needed? Think of the early work upon the just noticeable difference, upon the simple reaction, upon the 'time sense'; or think of Wundt's current discussion of Weber's and Merkel's laws!

of the problems of experimental psychology. The psychologist of the laboratory is apt to emphasize the crudity and roughness of the work, and its neglect of introspective control; the psychologist of the clinic or the schoolroom or the animal room is apt to consider his colleague narrow and his colleague's work finical and meticulous. The transcending of this difference, the reconciliation of these views, I take to be a very real problem for experimental psychology—though a problem of a different order from those that I have been discussing. And I suggest the following points for your consideration. First, one can not be too nice or too careful in experimenting on mind. There is no such thing as over-refinement of method.* Let those who doubt this fact read Martin and Müller's 'Unterschiedsempfindlichkeit'; the more delicately one analyzes, the more subtle does mental process reveal itself to be. Galton's questionary results on visualization are psychology, and valuable psychology; but they are also pioneer psychology. Now, the pioneer may pride himself on his work, but not on the roughness of his work. When the laboratory psychologist smiles at the charcoal sketches of objective experiment—well, he does wrong to smile, because honest work should not be laughed at; but he is right in his conviction that the details are all to come, and that the simplification of the lines means over-hasty generalization. Mind is, so to say, our common enemy; and the laboratory psychologist learns, by dearly bought experience, not to underestimate his opponent. Secondly, I would remind you that, after all, objective work in psychology must always be inferential; introspection gives the pattern, sets the standard, of analysis and explanation. If we interpret the animal mind by the law of parsimony, our only justification is that introspection discovers the reign of this law in the human consciousness; if we subsume the evolution of mind in the animal series to the principle of natural selection, our only justification is, again, that introspection discovers the working of this same principle in our own case. As I put it just now, there is but one excuse for the neglect of introspection in psychology, and that is that introspection is impossible; but even here our neglect is methodical only, and does not—must not—extend to interpretation. These things have been said so often* that they have become commonplaces; but even a commonplace may be true—and it makes a difference, too, whether the truth be urged with polemical or with friendly intent. I should like to see more cooperation between the alienist, or the student of comparative psychology, and the laboratory psychologist; quite apart from practical results, such cooperation would be of great advantage to the psychological system. We can hardly hope —this point should be borne in mind—that the two interests, the objective and the subjective, will be combined in the same person. When one has once stepped inside the ring of the normal, adult consciousness, there is very little temptation to step out again; the problems that I listed a little while ago are enough to occupy several generations of workers, and the fascination of the work is like the fascination of the mountains or the sea. And if one begins from the outside, with the child or the animal or the abnormal mind, there is little

* A method may be too refined for the man who is using it, or for the problem upon which he is immediately engaged. But these are different matters.

* In saying them, from the 'narrower' point of view, I am, of course, hoping for similar cautions (at any rate, for varied advice and information) from the more 'objective' psychologists. What they will have to tell their colleagues of the laboratory, I do not know; but I have no doubt that it will be worth listening to.

likelihood that one can breathe the confining air of the laboratory, or that one will presently limit one's range of interests to oneself. Partly it is a matter of temperament, partly a matter of chance introduction or of continued occupation. The two types of psychologist are distinct: all the more reason that they should work in harmonious cooperation.

I hope that, in this latter portion of my address, I have not traveled too far out of the record. Some men have problems thrust upon them. And, after all, if what I have said contributes ever so little to the furtherance of mutual aid and the increase of mutual esteem, as between psychologists of different camps, I may hope for forgiveness, even though I have exceeded the letter of my instructions. Now let me briefly summarize what I have said. I began, you will remember, by pointing out that, above and apart from the many special problems of experimental psychology, there lies the great problem of self-definition, of the range and scope of the experimental method in psychology. Then, under the headings of psychology proper and of psychophysics, I called your attention to a series of laboratory problems that, more or less insistently, more or less immediately, call for solution. Whatever else experimental psychology may be, I said, these issues are issues of experimental psychology. Incidentally, I deprecated any departure, at the bidding of philosophy, from the straight path of psychological investigation; and I deprecated also that neglect of introspective control in psychology which has been the besetting sin of many whose direct interest lies in psychophysics. I then went on to include in experimental psychology the more objective applications of the experimental method in child psychology, in animal psychology, in abnormal psychology. It was not my province to detail the special questions in these fields; they form the topic of other addresses in other sections. But I should regard as incomplete any review of the problems of experimental psychology which omitted reference to them. Their consideration helps us to attack that first problem of definition, clarifies our method, and furnishes an opportunity for the give-and-take of criticism and encouragement. We can not afford to misunderstand one another, as we can not afford to waste our time on unreal and constructive problems. The work presses; the rule of work is definite and unmistakable; there is room in the workshop for all sorts and conditions of men. I do not think that the outlook of any science could be more hopeful; I do not think that we need fear a lessening of that quiet enthusiasm which, from the first, in the beginner as in the mature student, has been the salient characteristic of the experimental psychologist.

E. B. Titchener.

SCIENTIFIC BOOKS.

An Introduction to the Theory of Mental and Social Measurements. By Edward L. Thorndike. New York, The Science Press. 1904. Pp. 212. 8vo. Price, $1.50.

In this book Dr. Thorndike has undertaken to explain the 'meaning and use' of recent contributions to statistical theory 'in common language to a common-sense thinker.' "Knowledge will be presupposed of only the elements of arithmetic and algebra. Artificial symbols will be used only where they are really convenient." In order are discussed: Units of measurement, the measurement of an individual and a group, the causes of variability and the theory of probability, the arithmetic of calculating central tendencies and variabilities, the transmutation of measures by relative position into terms of units of amount, the measurement of differences, changes and relationships and the use of tables, reliability of measures and errors of measurements.

On the whole, the author's aim seems to be realized, although it takes over 200 pages. The frequency polygon, as a whole, is properly declared to be the unit of comparison which its constants by no means fully replace. The methods of determining the average, standard derivation and probable error are fully set forth and the explanation of the method of calculating the coefficient of correlation is particularly good.

Great stress is laid—properly enough in a book intended for psychologists whose material is not always directly measurable—on measurement by position and the transmutation of position into units of amount. Such a transmutation is easily effected when the frequency distribution is approximately normal. A little table, based on the table of the normal probability integral, is given, showing the deviation from the mean (in units of the standard deviation) of each per cent. class from 1 to 50. A handy table is also given showing the average deviation of any number of consecutive percentage classes. Of course, there is nothing new in this, but it helps to have the importance of the measure by relative position insisted on in a popular treatise of this sort, because it is not popularly understood.

In treating the measure of differences emphasis is laid on the importance of comparing the entire distributions rather than the averages only. The degree of overlapping of the frequency polygons gives the best insight into the degree of difference.

Under 'Measurement of Relationships' the measurement of correlation is considered and the Pearsonian method of analysis is plainly and fully set forth. In the chapter on 'Reliability of Measures' the determination of the probable error of the average and of a difference between two averages is fully described.

The book abounds in tables giving various statistical data. There is appended a multiplication table up to 100×100; also a table of squares and square roots. A table of the normal probability integral (apparently copied without credit from the reviewer's 'Statistical Methods') is found on page 148. A feature of the work is a set of 'Problems' at the end of each chapter.

The reviewer has noted in passing several defects which are mentioned here in order that they may be guarded against in the second edition. Part of Fig. 12 seems to be inverted. The 'Mode' is repeatedly spoken of where empirical and not theoretical mode is meant. The distinction should always be clearly made. Also, the mode is not the 'apex of the slope' (p. 73), but the abscissa of the apex. The method suggested of finding the mode is unnecessarily clumsy. The mode is approximately equal to the mean less $3 \times$ (mean $-$ median). Tables XXXI. and XXXII., the first value of σ would seem to be a misprint for 2.57.

On the whole, we believe the book will be found very useful, especially in making more familiar the frequency polygon and leading to its more frequent publication in statistics in place of the bare average. And so we trust that it will be widely studied and its recommendations followed. C. B. DAVENPORT.

American Hydroids. Part II. *The Sertularidæ.* With 41 plates. By C. C. NUTTING. Special Bulletin, U. S. National Museum. 1904.

The first part of this magnificent work, on the Plumularidæ, appeared in 1900, and was noticed at some length in our columns. Much of what was said about Part I. is equally applicable to Part II., and need not be repeated. Some idea of the value of the work may be gained from the fact that not more than 20 species of Sertularidæ from American waters have heretofore been discussed in any single publication, and now Professor Nutting presents us with complete descriptions and figures of no less than 130! These species, distributed by the author in ten genera, have been named by the following writers: Nutting, 37; Allman, 16; Linnæus, 12; S. F. Clark, 9; Kirchenpauer, 8; Hartlaub and Mereschkowsky, each 5; Ellis and Solander, Hincks, Trask, d'Orbigny and H. B. Torrey, each 3; Levinsen, Alder, Bale, Marktanner-Turneretscher, Murray and Lepechin, each 2; and J. E. Gray, McCready, Versluys, Poeppig, Stimpson, Sars,

Lamouroux, Meyen, Fewkes, Johnston, Busk and Verrill, one each. These figures show that although many able zoologists have studied these animals, Nutting has done far more to make known the American species than any of his predecessors.

In a few instances I find myself unable to agree with Professor Nutting's nomenclature, if I rightly understand the facts. Thus *Thuiaria dalli* is a new name for *Sertularia cupressoides*, Clark, 1876, because it is a *Thuiaria*, and conflicts with *T. cupressoides*, Kirchenpauer, 1884. The rule here followed is that recognized by many botanists, but is, I think, losing ground, while it is not usually considered valid in zoology. Surely it would be more in accordance with zoological custom (and, I think, common sense) to give priority to the older specific name, no matter what genus it was placed in, and consequently rename the species of Kirchenpauer, not that of Clark.

The natural history department of the British Museum is constantly referred to as the 'South Kensington Museum,' which is not exact, and would be understood by Londoners to refer to a different institution.

T. D. A. Cockerell.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

The American Association for the Advancement of Science, the American Society of Naturalists and the following societies will meet at Philadelphia, Pa., during the week beginning December 24, 1904:

The American Association for the Advancement of Science.—The week beginning on December 27, President, Professor W. G. Farlow; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, President Charles S. Howe, Case School, Cleveland, Ohio; secretary of the council, Professor Clarence A. Waldo, Purdue University, Lafayette, Ind.

Local Executive Committee.—President, Provost Charles C. Harrison; vice-president, Professor Edgar F. Smith; secretary, Dr. Philip P. Calvert; treasurer, Dr. Samuel G. Dixon; chairman of the executive committee, Provost Charles C. Harrison; of the committee on reception and entertainment, Mrs. Charles C. Harrison; of the committee on hotels and boarding houses, Professor Amos P. Brown; of the committee on meeting places and equipment, Professor Edwin G. Conklin; of the committee on press and printing, Mr. George E. Nitzsche; of the committee on transportation, Mr. Walter Wood; of the committee on finance, Mr. S. F. Houston.

Section A, Mathematics and Astronomy.—Vice-president, Professor Alexander Ziwet, University of Michigan; Secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Wm. F. Magie, Princeton University; Secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Leonard P. Kinnicutt, Polytechnic Institute, Worcester, Mass.; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor David S. Jacobus, Stevens Institute, Hoboken, N. J.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Eugene A. Smith, University of Alabama; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Dr. C. Hart Merriam, U. S. Dept. of Agriculture; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Professor B. L. Robinson, Harvard University; Secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. Walter Hough, U. S. National Museum; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Vice-president, Martin A. Knapp, U. S. Interstate Commerce Commission, Washington; Secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor H. P. Bowditch, Harvard University.

The American Society of Naturalists.—December 27, 28. President, Professor E. L. Mark, Harvard University; secretary, Dr. Chas. B. Daven-

port, Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y.

The Astronomical and Astrophysical Society of America.—December 28, 29. President, Professor Simon Newcomb; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 30. President, Professor Arthur G. Webster; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 28–31. President, Professor Arthur A. Noyes, Massachusetts Institute of Technology; Secretary, Professor William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 29–31. President, Professor J. C. Branner, Stanford University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Botanical Society of America.—December 27–31. President, F. V. Coville; secretary, Dr. D. T. MacDougal, N. Y. Botanical Garden, Bronx Park, New York City.

The Society for Plant Morphology and Physiology.—December 28, 29, 30. President, Dr. G. T. Moore, Department of Agriculture, Washington; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

The Botanical Club of the Association.

The Fern Chapter.

Sullivant Moss Chapter.

Wild Flower Preservation Society of America.

The Society for Horticultural Science.—President, Professor L. H. Bailey, Cornell University; secretary, S. A. Beach, Geneva, N. Y.

The Society for the Promotion of Agricultural Science.—December 26. Secretary, Professor F. M. Webster, University of Illinois, Urbana, Ill.

The Association of Plant and Animal Breeders.

The Association of Economic Entomologists.—President, Professor A. L. Quaintance, Washington, D. C.; secretary, Professor H. E. Summers, Ames, Iowa.

The Entomological Club of the Association.

The American Society of Zoologists (Eastern Branch).—December 27, 28. President, Professor E. A. Andrews, Johns Hopkins University; secretary, Professor Gilman A. Drew, University of Maine.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor H. F. Osborn, Columbia University; secretary, Dr. O. P. Hay, American Museum of Natural History, New York City.

The Society of American Bacteriologists.—President, Professor F. G. Novy, University of Michigan; secretary, Professor F. P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December 27, 28. President, Professor R. H. Chittenden, Yale University; secretary, Professor Lafayette B. Mendel, New Haven.

The Association of American Anatomists. December 26, 27, 28. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

American Folk-Lore Society.

The American Anthropological Association.—December 27–Jan. 2. President, Dr. W J McGee, Washington; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Psychological Association.—December 28, 29. President, Professor William James, Harvard University; secretary, Professor Livingston Farrand, Columbia University, New York City.

The American Philosophical Association.—December 28, 29, 30. President, Professor George T. Ladd, Yale University; secretary, Professor H. N. Gardiner, Northampton, Mass.

The Sigma Xi Honorary Scientific Society.—President, Professor S. W. Williston, University of Chicago; secretary, Professor Edwin S. Crawley, University of Pennsylvania, Philadelphia, Pa.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 590th regular meeting was held November 12, President Marvin in the chair.

Mr. Marsden Manson, of San Francisco, presented by invitation a paper on 'The Evolution of Climate.' In opposition to the modern views which attribute geological climate to solar control and the glacial epoch to astronomical causes, the author emphasizes the influence of the dense aqueous atmosphere which must have surrounded the earth in early times, and the change that occurred when the sun's rays could reach the surface. The ice-age was a transition period between the long periods of earth-controlled and sun-controlled surface temperature. His conclusions were:

1. At the dawn of geologic time two sources of heat were active agents in the control and conservation of temperatures, (*a*) earth heat,

(*b*) solar energy converted in the upper atmosphere into heat.

2. The functions of these two sources were separate. Earth-heat controlled the surface temperatures during its prevalence, and by the laws of cooling solids was uniformly distributed at sea level; it was held near the planetary surface by the enshrouding media, by which it was trapped and through which it escaped slowly, not by direct radiation, but by the performance of work, namely the evaporation of water, and by convection currents which carried warm air to the upper regions of the atmosphere, from which regions only could free radiation of heat into space take place. Solar energy did not directly affect surface temperatures, during the existence of earth heat as a sensible factor, by reason of the intervention of a dense cloud-sphere incident to the universally warm oceans whose temperature is attested by early fossil life; but during this period solar energy acted as a conservator of planetary heat by warming the upper regions of the atmosphere and clouds.

3. Under these conditions, lower and lower temperatures supervened and were recorded by fossil life and ice action distinctly non-zonal in distribution, but varying locally through wide ranges by reason of differences in elevation.

4. Land areas reached glacial temperatures whenever and wherever they were thrust up above a snow-line controlled by earth heat, and such snow-line was in the main continuously lowered but may have fluctuated and was independent of latitude until the culmination of the ice-age; land areas reached glacial temperatures earlier than ocean areas, by reason of the low specific heat of earth and rocks, their more intense rate of radiation, through the cooling action of rain and snow and by reason of greater elevation, and they were subjected to maximum glaciation along lines of maximum precipitation, and may have escaped all but light local glaciation in regions of minimum cloud formation and precipitation.

5. Upon the cooling of the oceans, the effective remnant of earth-heat was exhausted and cloud formation reached a minimum, permitting solar energy to reach the surface and to assume domination and control of its temperatures; the climates of such control became zonal by reason of direct exposure to a zonally distributed source, and these climates gradually rose in temperature by reason of the trapping of heat rays emitted by the warming planetary surface; such rise is yet in progress as recorded by retreating glaciers and advancing plant and animal life.

6. These progressive changes of climate have been in harmony with the principles of climatic evolution herein set forth; and the principles are substantiated by the facts of geology and by the phenomena now taking place.

Mr. C. G. Abbot, of the Astrophysical Observatory, under the title 'Radiation and Terrestrial Temperature,' discussed the substantial equilibrium of temperature of the earth, and consequent equality of solar radiation absorbed in and about the earth to that emitted from and about the earth to space. After speaking of the great complexity of the earth and atmosphere as an absorber and radiator, certain maximum and minimum values of the solar constant and of the possible terrestrial temperature were obtained by considering the substitution of a black body or perfect radiator for the earth. In this way it was shown that the solar constant can not exceed 3.88 calories, and may be indefinitely below this according as the earth reflects less than 44 per cent. of solar radiation, or radiates to space less perfectly than a black body. Taking 1.9 calories as the minimum allowable assumption of the solar constant, it was shown that the mean temperature of the earth would remain above —33° C. if the earth were a perfect radiator and the reflection of solar rays did not exceed 44 per cent. Accordingly we owe not exceeding 58° rise of temperature to the imperfect radiation of the earth. But in the absence of clouds the mean earth temperature would certainly exceed 0° C. It appeared that if the temperature of the oceans could be raised 25° C. the cloudiness would so far increase as to make glaciation of the land a probable consequence. Professor Arrhenius's carbonic acid theory of glacia-

tion was discussed, and it was shown that the author of it had assumed the applicability of Stefan's law to the temperature of the gases of the air, and had neglected the dependence of connection between earth and air on the relative temperatures of the two in framing the theory. Inasmuch, therefore, as not only his fundamental equation and much of the numerical data which had been used in the computations were open to serious question, grave doubt was expressed as to the validity of Professor Arrhenius's computation of the effect of variation of the carbonic-acid contents of the air, and also of the glacial theory which Arrhenius and Chamberlin had founded upon it.

In the long discussion that followed several geologists dissented from Mr. Manson's views, holding that various important facts found no place in it.

CHARLES K. WEAD,
Secretary.

AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

THE first regular meeting of the season was held at the Chemists' Club, Friday evening, October 7. A number of the visiting English members of the Society of Chemical Industry were present as guests of the section. Mr. Chas. C. Cresswell, of London, the general secretary of the Society of Chemical Industry, gave a brief address, expressing appreciation of the many courtesies shown to the English members of the Society of Chemical Industry during their tour of the United States.

Doctor J. Lewkowitsch, of London, the well-known authority on oils, fats and waxes, then gave a discourse on the most recent advances in the chemistry of oils and fats. He mentioned, in the first instance, the theory of saponification of glycerides. Up till a few years ago the equation representing the hydrolysis of oils and fats, *i. e.*,

$$C_3H_5\begin{matrix}OR\\OR\\OR\end{matrix} + 3HOH = C_3H_5\begin{matrix}OH\\OH\\OH\end{matrix} + 3R\cdot OH,$$

was taken as the true expression of the reaction in the sense that one molecule of triglyceride was converted into one molecule of glycerol and three molecules of fatty acids. Geitel, however, first showed by physico-chemical experiments that the reaction underlying the hydrolysis is a bi-molecular one; according to this view the saponification of glycerides takes place in stages, the triglyceride passing through the diglyceride into monoglyceride, to be finally resolved into glycerol and free fatty acid. As the correctness of this view was doubted, he (Dr. Lewkowitsch) had tried to prove its correctness by purely chemical methods. If diglycerides and monoglycerides did appear as intermediate products in a partially saponified fat, then it should be possible to prove the presence of lower glycerides by converting the lower glycerides into a triglyceride by boiling with acetic anhydride. The then resulting triglycerides could be readily examined for the presence of acetyl groups. On carrying out the experiments, he actually proved that acetic acid was obtained on saponifying the acetylated mass. The acetic acid could be determined quantitatively in the usual manner. Now if a natural fat was saponified slowly in a manner simulating the process carried on on a large scale, and samples from the partially saponified mass were acetylated, varying amounts of acetic acid were obtained from them. On plotting the results in a system of coordinates, zigzag-like curves were observed. This proved that lower glycerides did occur in the partially saponified mass, and hence that the *progress* of saponification takes place in accordance with the view that the triglycerides pass through the diglycerides and monoglycerides, and that all three possible reactions occur simultaneously.

Dr. Lewkowitsch explained next his views on the hydrolysis of triglycerides and showed that water alone must be considered as the hydrolizing agent. The saponification processes applied in practise must, therefore, be explained by the assumption that the bases only act as catalyzers (or accelerators) and that the fundamental equation,

$$C_3H_5\begin{matrix}OR\\OR\\OR\end{matrix} + 3H_2O = C_3H_5\begin{matrix}OH\\OH\\OH\end{matrix} + 3ROH,$$

actually represents the primary chemical change. He fully explained this in the in-

stance of the saponification process by means of lime. In order to hydrolyze (saponify) a fat by means of lime in an open vat the theoretical quantity of CaO, namely, 9.7 per cent., was not sufficient to produce complete saponification, and no less than 12 to 14 per cent. were necessary to completely convert triglyceride into glycerol and the calcium salts of fatty acids. If the view were correct that the lime acts as an accelerator, then it should be possible to completely hydrolyze a triglyceride by a smaller amount of the base than theory requires for the complete saturation of the fatty acids. The theory further predicts that if the temperature and the pressure under which the reaction is carried out are increased, the amount of base may be reduced. As this is borne out by the methods practised on a large scale in which practically complete saponification is effected with from one to three per cent. of lime under pressures of twelve to eight atmospheres, the view that the bases act as accelerators was amply confirmed.

On the strength of the foregoing views one could give a rational explanation of the phenomenon of rancidity. In the first instance the triglycerides were hydrolyzed by the minute quantities of moisture which always found access to thin fats, however carefully they might be preserved. He likened the slow hydrolysis to the slow decomposition of granite in the course of centuries. The free fatty acids thus formed were then degraded in a secondary reaction into lower volatile acids, on being oxidized by the oxygen of the air, thereby acquiring that disagreeable taste and smell which we comprise under the term 'rancidity.'

Dr. Lewkowitsch next touched upon the discovery of mixed triglycerides in natural oils and fats. He first showed that theory predicted the existence of two isomeric monoglycerides, as also of two isomeric diglycerides having the same acid radical. Triglycerides, in which all three acid radicals had the same composition, could exist in only one form.

Thus in case two different acid radicals are combined with one molecule of glycerol, then theory predicted the existence of two isomerides, and if all three fatty acid radicals in one molecule of a triglyceride were different, then three different substances could exist.

The last-named class of glycerides was appropriately termed 'mixed glycerides.' The occurrence of such glycerides has been proved hitherto in a number of cases. Thus they were shown to exist in Kokum butter, cacao butter, olive oil, tallows, lard and human fat. The enormous amount of theoretically possible triglycerides opened out a wide vista of researches that would undoubtedly lead to important results in the near future.

Discussion.—In reply to Professor Bogert, Dr. Lewkowitsch said that it was almost certain that lecithin contained several fatty acid radicals in one molecule.

In reply to Dr. Ittner, Dr. Lewkowitsch agreed that optically active glycerides should exist theoretically, and he pointed to some work he had carried out over twenty years ago, when, basing himself on such theoretical considerations, he had resolved glyceric acid into two optically active components. As regards the acidic component of the glycerides, the fatty acids themselves had hitherto, with the exception of ricinoleic acid, been found optically inactive, but a few months ago Dr. Power had discovered in Chaulmoogra oil a new class of fatty acids, which were remarkable not only for containing a closed carbon ring, but also for exhibiting the property of rotating the plane of polarized light.

In reply to the chairman, Dr. Lewkowitsch pointed out that hydrolysis in alcoholic solution need not be looked upon as differing from the hydrolysis occurring in aqueous solution, if one looked upon C_2H_5 as being a basic ion. He himself thought that under pressure the conversion of a glyceride into ethylic esters might be carried out to a large extent, although, judging from the classical researches of Berthelot and Pean St. Giles he would not expect the reaction to be a complete one. The reaction may be explained by the two groups C_2H_5 and R changing places. The correctness of this view was proved by the fact, that if a fat was saponified in alcoholic solution in an insufficient amount of KOH, ethylic esters were obtained as the immediate products of

the reaction, which in their turn were hydrolyzed in a second stage with the formation of the potassium salts of the fatty acids.

The regular program of the evening was then taken up, and the following papers were read:

Inactive Thorium. CHARLES BASKERVILLE and FRITZ ZERBAN.

The authors continued the work on the complexity of thorium, in connection with the question of its radioactivity. They did not succeed, however, in entirely removing the activity from active thorium preparations, but they found originally inactive thorium in a rock from South America. This rock is gray, similar to slate, and consists mainly of barium carbonate. It does not show any radioactivity, emitting neither + nor — radiations. It contains only a small percentage of thorium and no uranium. The thorium from this source, identified by all the characteristic reactions, did not affect the photographic plate through black paper within 290 hours, nor did it give any evidence of radioactivity with the Elster and Geitel electroscope. Further investigations will be made concerning the elementary nature of this new variety of thorium, as no determination of its atomic weight has been made.

This work has been assisted by the Carnegie Institution.

The Use of Copper Sulphate as an Algacide in the Treatment of Water Supplies. DANIEL D. JACKSON.

Since the publication of the paper by Drs. Moore and Kellerman, of the Bureau of Plant Industry, U. S. Department of Agriculture, a very wide interest has been expressed in the use of copper sulphate in the treatment of water supplies. During the past five months more than fifty different sources of supply throughout the United States have been treated by this method, and the results obtained have exceeded all expectations. Both as an algacide and as a germicide the chemical is remarkable. Those micro-organisms which cause the greatest amount of trouble from tastes and odors in water supplies are the ones which are most effectively acted upon by this treatment. Also, the bacteria which are of intestinal origin are killed off with much higher dilutions than the ordinary germs.

The use of covered reservoirs to prevent microscopic growths will no longer be a necessity, as the copper sulphate treatment may be applied once or twice a year and prevent all trouble from those sources. The dilution required for such treatment is usually about one part of copper sulphate to eight million parts of water. This dilution is so great that in order to obtain a medicinal dose of the chemical it would be necessary for an individual to drink about forty gallons of water each day. After two or three days the copper is absolutely removed by precipitation.

Landscape architecture is also greatly benefited by this discovery, as unsightly and foul-smelling green growths in ponds and lakes can be easily removed and prevented. The Department of Water Supply and the Department of Parks of New York City have both had waters treated by the author during the summer with decided success, and in each case only one treatment extending for a period of one hour was necessary. The sulphate is applied by rowing a boat over the surface of the water, from the sides of which are suspended bags containing the crystals of copper sulphate. These are dissolved in the water as the boat is rowed over the surface.

The use of copper sulphate as a germicide is being very extensively experimented upon, and it is probable that typhoid fever will be entirely removed from any source of supply by a dilution of one part copper sulphate to two million parts water. In this case it is desirable to treat the contaminated stream or portions of supply at the source of the contamination, the treatment being applied at such a dilution that bacillus coli is removed.

Great credit is due Drs. Moore and Kellerman for their remarkable discovery of this treatment, which marks a decided advance in sanitary science and which undoubtedly will modify many engineering ideas regarding water supplies.

F. H. POUGH,
Secretary.

THE AMERICAN CHEMICAL SOCIETY.

NORTHEASTERN SECTION.

The fifty-fifth regular meeting of the section was held Friday evening, November 18, at the 'Tech Union,' Massachusetts Institute of Technology, with President W. H. Walker in the chair. About 150 members and guests were present. The following officers were elected for 1904–5:

President—James F. Norris.
Vice-President—Walter L. Jennings.
Secretary—Arthur M. Comey.
Treasurer—John W. Brown.
Executive Committee—Gregory P. Baxter, Edgar F. Billings, Robert S. Weston, Carl O. Weber, Lyman C. Newell.
Councillors—Charles R. Sanger, Charles L. Parsons, Albert E. Leach.

The annual reports of the secretary and treasurer were read.

President W. H. Walker opened the discussion of the subject of the 'Future Supply of Available Nitrogen,' by giving a résumé of the methods, by which the nitrogen, taken up by plants, is replaced by a fresh supply obtained from the air by chemical and electrical processes, describing the formation of calcium and barium carbamides, and the process and apparatus used for the direct conversion of nitrogen into nitric acid by using an electric arc.

Dr. George T. Moore, Director of the Laboratory of Plant Physiology of the U. S. Department of Agriculture, described the recent work carried on under his direction on the fixation of atmospheric nitrogen by means of bacteria, in which he described how the nodules formed on the roots of leguminous plants have been found to contain bacteria, which are able to fix the nitrogen of the air, and make it available for the use of the plants. These nodules are not formed naturally in all soils, owing to the lack of the presence of bacteria, and in order to make up for this deficiency, pure cultures of the bacteria in the nodules have been made and added to the soil. It was found if this was done, using the ordinary media containing nitrogen, that the bacteria were weakened, and no longer possessed the power of forming nodules, but if no nitrogen was present in the media used, the new organisms possessed the power of forming nodules to a high degree, when the seed or ground in which it was sown was inoculated with the cultures. These cultures have been dried on cotton, and distributed with the necessary food and directions for their development to about 10,000 farmers during the past year. The results so far sent in have been very satisfactory, the crop being increased in almost all instances by the use of the cultures, in some cases as high as 1,000 per cent. The lecture was fully illustrated with lantern slides, showing sections of the nodules, specimen plants, etc.

Arthur M. Comey,
Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY.

The 156th meeting of the Elisha Mitchell Scientific Society of the University of North Carolina was held in the chemical lecture room, Tuesday, November 8, 7:30 P. M., the following program being rendered:

Professor J. E. Mills: 'Molecular Attraction.'
Professor H. V. Wilson: 'Experiments on the Development of the Skeleton in Sponge Larvæ.'
Professor A. S. Wheeler: 'The Theories of Dyeing with Special Reference to the Constitution of Cellulose.'

Alvin S. Wheeler,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

STYLE IN SCIENTIFIC COMPOSITION.

The employment of a direct and perspicuous style is of immense advantage in scientific writing, perhaps more so than in other forms of literature. In scientific composition, as elsewhere, the art of writing well depends primarily upon *right thinking*, this being, as was said by Horace centuries ago, 'the beginning and fount of excellence'; and in scarcely inferior degree it depends upon *correct expression*. Concede with Pope that 'expression is the dress of thought,' and it follows that careless or faulty expression detracts as much from our appreciation of an author as slovenliness of apparel.

Superelegance of style is neither necessary nor desirable in every-day science, any more

than is fastidiousness as to the cut of working-clothes; but we have at least a right to expect accuracy of expression on the part of an author, and conformity to good literary usage, which means simply the 'consent of the learned.' Faults of beginners can be overlooked; but practised writers who plead haste as an excuse for uncomeliness are a reproach to the patricians of science, one of whom formulated the famous aphorism, '*Le style, c'est l'homme.*'

Any one can cultivate a fair style by taking sufficient pains, despising not the counsel of good masters, and, above all, by intimate association with the best authors. The classics are within reach of us all, in translated form at least, and one amongst them has never been surpassed for brevity, vividness and virility. We refer to Tacitus, of whom Senator Hoar ventures the opinion in his 'Autobiography,' that he is 'the best gymnastic training of the intellect, both in vigor and style, which the resources of all literature can supply.' His portrayal of Tigellinus, Nero's favorite, has been called 'the most damning epitaph ever penned by the hand of man'; its cold scorn is unsurpassed even by Byron's anathemas, such as make the 'Curse of Minerva' one of the most annihilating of poems.

Old Ben Jonson defines 'a strict and succinct' style as one 'where you can take away nothing without loss, and that loss to be manifest.' We learn from Ben how the best authors progressed in their beginnings: "They imposed upon themselves care and industry; they did nothing rashly; they obtained first to write well, and then custom made it easy and a habit. By little and little their matter showed itself to them more plentifully; their words answered, their composition followed; and all, as in a well-ordered family, presented itself in the place. So that the sum of all is, ready writing makes not good writing, but good writing brings on ready writing."

In geology, one of the most graceful of 'ready writers' was Hugh Miller, at whose style Agassiz marveled. Humboldt, Lyell, Darwin, all excelled in composition, as did our own Newberry; and the writings of many well-known contemporaries are models of neatness and precision. In paleontology, Cope's fecundity was at the expense of good form, his most brilliant contributions being marred, as Osborn has pointed out, by confusion of terms. This serious fault is of frequent occurrence elsewhere, and we may be permitted in what follows to devote some attention to it.

Inaccuracy in the use of terms, employment of inappropriate methods of illustration, anything in short which tends to impair the vocabulary of science and render it less efficient, are grave errors; for it is an axiom that the advancement of science depends as much upon expression as upon investigation. Yet there is one class of writers who apparently hold the matter of terminology in light esteem, the whole 'business' of technical expressions and methods of illustration being conducted contrary to the principles of good usage. Physiographers are the class of writers referred to, and we hope to accomplish some good by remonstrating mildly against certain of their improprieties.

First, as to descriptive terms. It is evident that the physiographic articles of faith include a firm belief in the penury of the English language, and unsuitability of Saxon epithets; otherwise it is impossible to explain their construction of a technical vocabulary out of a rabble of words recruited from the uttermost regions—part alien, part hybrid, part argot,—

> 'Scotch, English and slang, in promiscuous alliance,
> Something bad they must mean, though we can't make it out;—
> That they're all *anti*-English no Christian can doubt.'

When a foreign author can be found like Reclus, who gives in one of his works no fewer than seventy-five dialect designations for mountains, or a compatriot like Mr. Hill, who has imported whole cargos of choice Castillian (not all of the saponaceous variety)—the entire assortment is appropriated with glee. Other departments of science that can boast of but few barbarisms, such as *Gegenschein* for counterglow in astronomy, *Dreikanter* for

faceted pebbles in geology, together with *Reibungsbreccia, roches moutonnées,* and the like, are put to shame for their poverty. Time was when none but the untutored savage called hills 'ispatinows' and 'pahas,' and the Brahmin was left in undisputed possession of 'doabs.' In those artless days we were wont to say 'hillside' and 'pot-hole' when needful, without blushing for the uncouthness of our mother-tongue, and in blissful ignorance of such refinements as 'cuesta' and 'remolino.' But now that physiographers, like Sganarelle, 'have changed all that,' we are overcome at the thought of our unletteredness.

Sometimes, however, even Chinook and Hottentot fail, and in such plight it becomes necessary to improvise new terms on the spot. Recent coinage from a strenuous mint has enriched us with 'can't bes' and 'not yets'; may we not hope for 'has beens,' 'izzers' and 'come ons' (out west they have them already) to complete the sequence? Another bright medallion is 'inglenook,' though had the choice been left to us we would have preferred 'tiddledywink'; and there are similar jeweled expressions too numerous to mention.

Whether this sort of a polyglot-colloquial nomenclature accords well with the dignity of science we leave others to judge. But before physiographers can claim the authority of good usage they must get the majority of the people to agree with them. Ere that time comes, however, we may be permitted to set some store upon Spencer's 'Philosophy of Style,' upon Pope's great neo-classic essay, and upon the raillery of that master of satire, who says:

'Nor slight applause will candid pens afford
To him who furnishes a wanting word.
Then fear not, if 'tis needful, to produce
Some term unknown, or obsolete in use,
* * * * * * * * *
New words find credit in these latter days,
If neatly grafted on a Gallic phrase.'

In the second place, as to methods of illustration. Readers of Science, and of John Burroughs's articles in the *Century* and *Atlantic Monthly,* are familiar with the attitude displayed by our best critics toward the popular fetich of humanizing the animal kingdom. The physiographic cult, *mirabile dictu,* aims at nothing short of humanizing the universe. The earth, to them, is a sentient being; land and sea are considered as alive; moral character an attribute of the elemental forces of nature.

Modern physiographic literature appears to be chiefly concerned with the working out of these and similar ideas *in extenso.* Everywhere is the aim to impart instruction by means of false analogy. The method of indirectness is exalted, the method of allegory, of wrong metaphor; the method that seeks to flatter minds that are quick to act on suggestion, that appeals chiefly to childish and savage intelligence. For the enlightened understanding resents having truth served up to it in spurious form. We tire of having things depicted not as they are, but grossly caricatured. In the end we lose all patience, as did old Ben when he complained that 'barbarous phrases often made him out of love with good sense, and wrong sense wracked him beyond endurance.' Then it is we wish writers would take Burroughs's advice to heart, who bids us to 'humanize facts to the extent of making them interesting, if you have the art to do it, but leave a dog a dog, and a straddlebug a straddlebug.'

Lest any suppose these strictures to be unduly severe, a few random illustrations may be offered in proof of the contrary. Certainly refined usage does not warrant the likening of topographic features to human nurslings, nor even to precocious infants,* as they have been likened. To refer a land surface to the 'puppy stage' would be ridiculous; but not one particle less so is the current series of technical terms taken from human infancy, adolescence, maturity and senility. The analogy is false, and therefore improper. Not less extravagant are the analogies taken from birth, rejuvenation and decease, including even violent death by 'drowning' or 'behead-

* The Grand Canyon of the Colorado is solemnly cited as an example of a 'precocious infant' in one of the best of modern text-books on physiography (Dryer's, 1901). Human growth-stages are even ascribed to heavenly bodies, as witness Professor Todd's account in 'The New Astronomy.'

ing,' a fate to which land and water forms are stated to fall prey. An example of a country that has apparently gone wading 'up to its knees' has been mentioned in a previous article (No. 498).

A favorite habit of physiographers is to represent rivers as wandering around with the intent of 'discovering' something, or 'attacking' or 'defending' themselves against a foe. 'Strategy' and 'tactics' are employed by a class of desperate characters known technically as 'pirates,' which, when successful, result in the 'decapitation' or 'capture' of the object of their 'assault.' The mysteries of 'sand-tactics' and 'island-tying' are revealed only to the initiated who have fully mastered this hierarchal language. We forbear to enumerate further examples, or to offer presumptuous comments on the nomenclature; but if any shall be so bold as to contend that it is dignified, and sanctioned by tradition and good taste, we may venture to entertain some doubt.

C. R. EASTMAN.
HARVARD UNIVERSITY.

SPECIAL ARTICLES.

'BERYLLIUM' OR 'GLUCINUM.'

SINCE the Council of the American Chemical Society has requested the smaller International Committee on Atomic Weights to submit the question of choice between the two names 'beryllium' and 'glucinum' to the whole or larger committee in order that uniformity of usage may be secured it is evident that a considerable difference of opinion exists among American chemists as to the advisability of adopting the latter name.

The question is one of decided importance in indexing our chemical literature, and as I have had this matter brought continually to my attention during the preparation of a bibliography of the element, now complete in card form, I should like to present the very strong reasons for the universal use of 'beryllium,' at least as they appear to me. These reasons are two and may be summarized as (1) priority and (2) usage.

Priority.—It has been generally supposed by chemists who have not carefully looked into the matter that the name 'glucinum' or at least 'glucine' originated with Vauquelin, the discoverer of the element, but this is not the case. In fact a distinction should be made between the terms 'glucinum' and 'glucine' for the former first came into use many years afterward when the metal itself was obtained and the real claim for priority must be a question between 'glucine' and 'berylerde' from which the others were derived.

Vauquelin himself uses the clause 'la terre du Béril' exclusively in his first two articles on the subject in speaking of the new oxide he had discovered (*Annales de chim.*, 26, 155, and 26, 170). The term 'glucine' was proposed by the then editors of the *Annales*, Guyton and Fourcroy, in a note at the end of Vauquelin's first article and signed simply 'Redacteur.' Vauquelin evidently presented his results for the second time to the French Society of Mines, for they again appear in the *Journal des mines*, 8, 553. Here also Vauquelin uses only the clause 'la terre du Béril' but gives support to the term 'glucine' by a note at the end of his article as follows: "La propriété la plus caracteristique de cette terre étant de former du sels d'une saveur sucrée, les C^ens. Guyton et Fourcroy m'ont conseillé de lui donne le nom de glucine de (γλυκης), doux, Cette denomination sera assez significante pour aider le mémoire; elle ne prendra pas dans son étymologie un sens trop strictement determiné, et ne presentera pas d'ideas fausement exclusive, comme celles que l'on tire du nom de la pierre qui fourni le premier échantillon de la substance nouvelle, etc."

Vauquelin's adoption of 'glucine' appears from the character of the argument he puts forth to be at least half hearted. He first actually employs 'glucine' in his third article entitled 'Analyse de l'emeraude du Péron' (*Annales de chim.*, 26, 259), prefacing its use with 'on a donné le nom de glucine.'

The clause 'la terre du Béril' was translated into German as 'Berylerde' in the reprints of Vauquelin's articles and became the name used thereafter by all of the German and Swedish chemists who did much the larger portion of the work of developing the chemistry of the element.

Usage.—If 'use is the law of language' then the supporters of 'glucinum' have little upon which to base their argument. By far the larger number of investigators of the element and its compounds have used and are using 'beryllium.' All the leading chemical journals of the world with the exception of those in the French language give preference to the latter term and in most cases use it exclusively. The German, Swedish and Dutch chemists who have the greater number of original articles to their credit use no other. Italians use 'berillio' from the same root. English journals until recently used the name prefered by the particular author but they have now almost ceased to put even the 'glucinum, see beryllium' in their indexes.

For American chemists to attempt to bring the world to the use of 'glucinum' when by far the majority of chemical journals have dropped it even as a synonym is, in my opinion, worse than useless even if there was a preponderance of argument in its favor.

Charles Lathrop Parsons.
New Hampshire College,
November 11, 1904.

CURRENT NOTES ON METEOROLOGY.

CLIMATE OF BALTIMORE.

The Maryland Weather Service has issued a valuable 'Report on the Climate and Weather of Baltimore and Vicinity,' by Dr. O. L. Fassig, section director of the U. S. Weather Bureau in Baltimore, and in charge of meteorological instruction in Johns Hopkins University. This volume ('Special Publication,' Vol. II., Part Ia., 1904) was preceded, in 1899, by Vol. I., in which a report on the physiography of Maryland was followed by papers on 'The Aims and Methods of Meteorological Work, Especially as Conducted by State Weather Services,' by Professor Cleveland Abbe; 'A Sketch of the Progress of Meteorology in Maryland and Delaware,' by Dr. O. L. Fassig, and an 'Outline of the Present Knowledge of the Meteorology and Climatology of Maryland,' by F. J. Walz. The present report is modelled on the lines of climatological discussions laid down by Hann, in his 'Handbuch der Klimatologie,' Vol. I., and is the first, in point of completeness and thoroughly scientific quality, of American publications on the climatology of special areas. There are numerous graphic illustrations of the variations of the different elements, which help greatly in an adequate understanding of the conditions discussed. Each element is considered with reference to (*a*) its diurnal period, (*b*) its annual period, and (*c*) its variability, or non-periodic aspects of long and short duration. In the present issue, Part Ia, atmospheric pressure and temperature are considered. The discussion of humidity, precipitation, cloudiness and sunshine, and winds, is reserved for a later issue, now in press. Part II. will concern 'Weather.' Dr. Fassig is to be congratulated on the successful accomplishment of what has certainly been an arduous task. He has the satisfaction of knowing that he has given American climatology an impetus which it sadly needed.

CYCLONES OF THE FAR EAST.

In 1897 there was published by the Manila Observatory a monograph entitled, 'Baguios ó Ciclónes filipinos,' in which Father José Algué, S.J., director of that institution, summarized what was then known concerning the typhoons of the Philippine Islands. A German translation, by Dr. Paul Bergholz, appeared in 1900, under the title, 'Die Orkane des fernen Ostens,' and an English translation of Dr. Bergholz's translation, by Dr. R. H. Scott, was published in 1901. In an enlarged edition, with the addition of newer material, and of a more complete discussion, we now have a volume of 283 quarto pages (Manila, 1904), issued as a 'Special Report of the Director of the Philippine Weather Bureau,' and bearing the stamp, Department of the Interior, Weather Bureau. The title has been changed to 'The Cyclones of the Far East,' because the field covered is larger than that in the case of the first edition of 'Baguios ó Ciclónes *filipinos*.' Among the more notable additions to the new edition are a fourth part, dealing with practical rules for navigating, and giving a list of ports of refuge in the far east, especially in the Philippine Archipelago; a new

classification of cyclones of the far east, and the relation between the average motion of the higher clouds in the northern hemisphere and the general cyclonic tracks.

CLIMATE OF THE PHILIPPINES.

PHILIPPINE climatology is a subject which interests a considerable number of Americans, and it is well that there should be generally available an authoritative presentation of the most important facts in this connection. In the 'Report of the Philippine Commission' for 1900, there was published an account of Philippine climates, and this, with some additions and many modifications, appears in Bulletin 2, Census of the Philippine Islands, 1903, 'The Climate of the Philippines,' by Father José Algué, S.J. (Department of Commerce and Labor, Bureau of the Census, 1904, 8vo, pp. 103). The bulletin is illustrated by means of twenty-seven plates, showing graphically the variations of the different climatic elements, the tracks of typhoons, etc., and there are also two colored maps of the islands, showing the mean annual rainfall and the mean annual temperature. On the latter, four shades of yellow are employed to indicate respectively the regions of high, intermediate and mild temperature, and also cool temperature 'because of altitude.' Of course, the word *cool* is relative, and the lower temperatures of higher altitudes in the tropics do not mean seasonal changes such as are experienced in the extra-tropics, especially in the northern hemisphere. R. DEC. WARD.

GOSSIP ABOUT LAMARCK.

A MOVEMENT is afoot in Paris, to erect, probably in the Jardin des Plantes, an imposing monument to Lamarck. This will take the form of a bronze bust, or possibly a statue, surmounting a large stone base, and on the latter, after the fashion in French design (as in the newly dedicated monument to Pasteur) figures will appear in full relief. In the present case, these will represent the naturalist, blind and infirm, seated on a bench in the Jardin, and standing by his side his devoted daughter, pronouncing her memorable prophecy. And one might add that the little model of this relief loses none of its pathos when one sees it in the historic house, in the room indeed in which Lamarck suffered and died.

The proposed monument is but one of the many signs that interest in the work of Lamarck is increasing among French zoologists. M. Landrieu, au élève of Giard, has prepared a translation of Packard's 'Life of Lamarck,' but we are told that he has added to it so much material that it will appear almost as a new work. It will shortly be published as a separate volume of the Zoological Society publications (Paris). In this regard it may be added that, thanks to the cooperation of a number of French scientists, notably Professor Hamy and Professor Joubin, M. Landrieu has been able to glean many details as to the life of the French naturalist. Some of these details, it appears, have been obtained through members of Lamarck's family, his descendants having finally been traced, and, curiously enough, one has still a personal interest in the Jardin, if for no other reason than that she has married one of the professors. It appears, furthermore, that a descendant of Lamarck is at present high in station, and is indeed, if gossip be repeated, slightly annoyed at the prominence which is being given an ancestor who was in his day obscure and who was, above all things, tainted with republicanism! An interesting item, which I learned recently from one of the authorities of the Jardin, is that there probably exist many memorabilia* of the naturalist; among them, for example, is a sketch book which was known to contain many portrait sketches of him made by one of

* In this regard *cf.* SCIENCE, 1904, vol. XIX., pp. 798–800, as to a recently discovered letter signed by Lamarck and Geoffroy (1796) dealing with evolutional matters. The writer may also mention that he has in his possession what is said to be the lid of Lamarck's *tabatière*. It is ivory-rimmed, and in the glass top appears a signature of Jean Jacques, together with a specimen of *Hypnum proliferum*. The name of the plant is in Lamarck's hand, and the specimen is possibly a souvenir of Lamarck's friendship with Rousseau and of their traditional walks on Mont Valérien.

his sons. An original portrait has also been discovered painted between 1795 and 1799. *A propos* of the family of Lamarck, I noticed that the library of the Institute has preserved one of the *annonces* sent out by Lamarck on the occasion of the wedding of his son, the engineer, Auguste de Lamarck; and that, in another file, a nephew, Auguste de Longschamps, is mentioned (1825) as having been given the privileges of the library. The archives of the Institute, however, I am sorry to say, fail to show the unpublished portion of Cuvier's éloge of Lamarck: this we hope may still be forthcoming among the extensive papers of Cuvier which the library has recently acquired. The missing portion of the éloge, it need hardly be mentioned, is of special interest, since it will probably throw light on a side of Lamarck's life and work which must to no little degree have been responsible for his neglect. For the rest I may quote an explanation of the contemporary lack of appreciation of Lamarck which was made by an eminent professor at the Jardin. "Lamarck," he said, "was found to be lamentably weak in the facts upon which he based his theories, geological, chemical and meteorological: and as an immediate result his views in these fields came in course of time to be regarded as chimerical. Was it not natural, therefore, that both his friends and foes should query whether his evolutionary doctrines were better founded? His methods were thus known to be in strong contrast to those of Cuvier, who, whatever were his limitations, had at least a thoroughly modern spirit in his laborious quest for facts with which to test the relation between cause and effect."

A final item is the installation in the Jardin des Plantes of a Lamarckian museum. This has been brought together during the past year by Professor Joubin and placed appropriately in a room adjoining the malacological collection. It aims to include all specimens which are known to have passed through the hands of Lamarck. The identification of this material, which thus far consists entirely of invertebrates, has proven by no means an easy task, for original labels have frequently been displaced or lost, or covered by later labels. It is to be hoped that the authorities may see fit to extend the scope of the museum in many directions.

B. D.

THE TOTAL ECLIPSE OF SEPTEMBER 9, 1904.

A TOTAL eclipse of the sun occurred on September 9, 1904. The shadow path crossed the central Pacific Ocean from west to east without touching known land, except that it reached the coast of northern Chile six or eight minutes before sunset. Astronomer William H. Wright, in charge of the D. O. Mills expedition from the Lick Observatory to Santiago, Chile, states that Dr. Obrecht, director of the National Observatory of Chile, established an observing station at Taltal, but that the sky was cloudy at the time of totality. At Santiago the sun set, partially eclipsed, on a fine horizon.

W. W. C.

LICK OBSERVATORY, UNIVERSITY OF CALIFORNIA, November 29, 1904.

THE AMERICAN SOCIETY OF VERTEBRATE PALEONTOLOGISTS.

THE American Society of Vertebrate Paleontologists will hold its second annual meeting in Philadelphia on December 28 to 30. By arrangement with the American Association for the Advancement of Science the meetings of the Zoological Section of the association will be held in the mornings while those of the Paleontological Society will be held in the afternoons at the same time that the Zoological Society is in session. Thus it is understood that the meetings of both societies will not conflict with the morning sessions of the American Association section, in which the papers will be of a general character.

For the Paleontological Society papers are already promised by Messrs. Osborn, Scott, Sinclair, Matthew, Merriam, Loomis and Hay. The presidential address by Professor Osborn will be entitled 'Ten Years' Progress in Mammalian Paleontology,' including a résumé of the principal discoveries of the past ten years and their bearing upon present and future problems. There will also be a discussion on the evolution and classification of the Reptilia,

in which Messrs. Williston, McGregor, Osborn and others will participate. Titles of papers should be sent to Dr. O. P. Hay, secretary, American Museum of Natural History, New York.

THE AMERICAN SOCIETY OF NATURALISTS.

THE twenty-third annual meeting of the American Society of Naturalists will be held at Philadelphia on Tuesday, December 27, and Wednesday, December 28. The following program is announced: Tuesday, 8:00 P.M., illustrated lecture by Professor Henry F. Osborn, 'Recent Discoveries of Extinct Animals in the Rocky Mountain Region and their Bearings on Present Problems of Evolution,' at the lecture hall of the Academy of Natural Sciences, Nineteenth and Race Streets; 9:00 P.M., smoker of the Affiliated Scientific Societies, University Club, Fifteenth and Walnut Streets. On Wednesday a business meeting will be held at 2 P.M. in the Laboratory of Physiology and Pathology at the University of Pennsylvania, and in the same place at 3 P.M. the annual discussion will take place. The topic, 'The Mutation Theory of Organic Evolution,' will be discussed from the following standpoints: Plant breeding, by Dr. D. T. MacDougal, of the New York Botanical Garden; animal breeding, by Professor W. E. Castle, of Harvard University; cytology, by Professor E. G. Conklin, of the University of Pennsylvania; paleontology, by Professor W. B. Scott, of Princeton University; anatomy, by Professor Thomas Dwight, of the Harvard Medical School; taxonomy, by Professor Liberty H. Bailey, of Cornell University; and ethology, by Dr. W. M. Wheeler, of the American Museum of Natural History. Each speaker is limited to fifteen minutes. At 6:45 a business meeting for the election of officers will be held at the Hotel Walton, while at 7:00 P. M. the dinner of the Naturalists, in which members of the affiliated societies may participate, will be held. At the dinner the president of the society, Professor E. L. Mark, of Harvard University, will give his address. Hotel headquarters of the society are to be at the Colonnade Hotel, Fifteenth and Chestnut Streets.

SCIENTIFIC NOTES AND NEWS.

THE trustees of the Carnegie Institution will meet at Washington on December 13, when it is expected that a president will be elected to fill the vacancy caused by the resignation of Dr. D. C. Gilman.

THE former students of Professor Charles E. Bessey who are connected with the Office of Vegetable Pathological and Physiological Investigations, Department of Agriculture, have had an enlarged copy of his photograph framed and presented to the office. The portrait, which had been covered with an American flag, was unveiled by Professor Bessey's son, Dr. E. A. Bessey. The picture was hung at a gathering of the office force on November 28. Miss Carrie Harrison presented the picture, and appropriate remarks were made by Mr. A. F. Woods, chief pathologist and physiologist, who spoke especially of Professor Bessey's work in promoting the establishment of the pathological and physiological work of the department and of his constant interest in its progress and welfare. Dr. H. J. Webber, physiologist in charge of plant breeding, spoke of the important part that Professor Bessey had taken in introducing laboratory methods of teaching botany in this country and of his great success as a teacher. Mr. C. L. Shear, pathologist, spoke briefly of his students, referring especially to those who are now holding important positions as professors of botany in various universities and colleges. All testified to the intimate and friendly relation which existed between Professor Bessey and his students and to their great admiration and affection for him.

The seventieth birthday of Dr. George H. Howison, Mills professor of philosophy in the University of California, was celebrated on November 29. A *Festschrift* has been issued by the university press containing contributions by his former pupils.

AT the last meeting of the Rumford Committee of the American Academy of Arts and Sciences the following grants for research were made: To Professor R. W. Wood, of Johns Hopkins University, $350, in aid of a research on the optical and physical properties of so-

dium vapor. To Professor N. A. Kent, of Wabash College, $100, additional, in aid of a research on the circuit conditions influencing electric spark lines. To Professor A. L. Clark, of Bates College, $150, additional, in aid of a research in the molecular properties of vapors in the neighborhood of the critical point.

DR. J. STEINDACHNER, director of the Natural History Museum at Vienna, celebrated on November 11 his seventieth birthday.

A CHAPTER of the Scientific Society of the Sigma Xi has recently been organized at the University of Indiana with Dr. W. L. Bryan as president.

MR. DAVID HALE NEWLAND has recently been appointed assistant state geologist of New York, as the result of civil service examinations. Mr. Newland, who will have special charge of inorganic and economic geology, graduated from Hamilton College about ten years ago, subsequently studied two years in Germany, was fellow in geology at Columbia University, assistant on the New York State Geological Survey, and for several years past has been on the editorial staff of the *Engineering and Mining Journal.*

DR. HENRY MONTGOMERY, for ten years past professor of geology and biology and curator of the museum at Trinity University, has been appointed curator of the museum at the University of Toronto.

AFTER the conclusion of his course of lectures at the Lowell Institute, Boston, on 'Selected Chapters in Physiography,' Professor Albrecht Penck gave three lectures before the Harvard Geological Conference on the 'Alps in the Great Ice Age,' the first considering Climatic Variations of the Ice Age (November 28); the second, Glacial Sculpture of the Alps (November 29), and the third, Man and the Ice Age (November 30). These lectures presented the chief results contained in the monograph 'Die Alpen im Eiszeitalter,' the joint work of Professors Penck and Brückner, now nearing completion. Professor Penck also gave an illustrated lecture before the Section of Geology and Mineralogy of the New York Academy of Sciences, on December 2, on 'The Surface Features of the Alps.'

DR. FRANZ BOAS, of Columbia University and the American Museum of Natural History, lectured at Harvard University on December 2, under the auspices of the Anthropological Society on 'Characteristics of Primitive Culture.'

AT University College, London, Professor W. F. R. Weldon is giving a course of eight lectures on 'Current Theories of the Hereditary Process' and Mr. G. U. Yule is giving a course of six Newmarch lectures on 'The Vital Statistics of England.'

ON November 13 the monument erected to the memory of Professor Ollier, the distinguished French surgeon, by international subscription, was unveiled at Lyons in the presence of M. Chaumié, minister of public instruction.

THE Danish Parliament has voted a pension of about $1,000 a year to the widow of the late Professor Finsen.

THE portraits of Professor Osborne Reynolds and Professor A. S. Wilkins, by the Hon. John Collier, were formally presented to the Victoria University of Manchester on November 18.

THE death is announced of Dr. W. L. Coleman, of Houston, Texas, known for his work on yellow fever.

THE cornerstone of the central building of the Rockefeller Institute for Medical Research was laid on December 3 by Dr. Simon Flexner, director of the institute. The building, which is at Sixty-fifth Street and Avenue A, will have a frontage of one hundred feet, will be five stories in height and will cost $345,000.

AT the monthly meeting of the Zoological Society of London it was announced that the total number of visitors to the society's gardens during the months of August, September and October had been 256,630, showing an increase of 7,236 as compared with the corresponding period in 1903.

THE New York *Evening Post* states that preparations are being advanced for the expeditions to be sent by the University of California, through the aid of Mr. William H. Crocker, to observe the next total eclipse of

the sun. Parties will go from the Lick Observatory to Spain, Labrador and Egypt. Professor Svante Arrhenius, of Stockholm, a member of the faculty for the last summer session, and Professor Wilhelm Ostwald, of Leipsic, will join the expedition which will go to Spain under the personal charge of Director W. W. Campbell.

PROFESSOR CHITTENDEN, director of the Sheffield Scientific School, has announced a gift from George J. Brush, late director of the institution and emeritus professor of mineralogy, of his valuable collection of minerals and of his scientific library, chiefly of mineralogical books and journals. In addition is given a fund of ten thousand dollars, the income of which is to be used for the increase and care of the collection and library. The value of the entire donation is estimated at about forty thousand dollars. The Brush collection of minerals, which has been recently placed in Kirtland Hall, is the result of over fifty years of judicious and painstaking selection of choice specimens from nearly all parts of the world. Much of it was collected by the donor himself. It has been formed especially to illustrate the scientific aspects of the subject of mineralogy and for study and investigation. It is particularly rich in the original type specimens of new minerals and in other material which has been investigated and published upon. For this reason it is known to scientists and collectors everywhere as having an especial value, and it is a matter of congratulation among friends of the institution that, through the kindness of the donor, this famous and valuable collection has been secured for the perpetual use of the school. It will be henceforth under the charge of Professor S. L. Penfield, who will act as curator.

THE department of geology of Bryn Mawr College has recently been presented, by Mrs. Charles Stillwell Eldredge, daughter of the late Theodore D. Rand, of Radnor, Pa., with her father's private rock and mineral collections. Mr. Rand, for thirty-one years treasurer of the American Institute of Mining Engineers, was an enthusiastic and discriminating collector of minerals and had secured, at the time of his death, some twenty to thirty thousand specimens. Among them are many rare minerals seldom found in private collections and many valuable and interesting crystals and mineral pseudomorphs. The rock collection is limited in geographic distribution to the United States and is chiefly illustrative of the crystalline rocks of eastern Pennsylvania. It includes a fine series of polished serpentines and rock-type, to which Mr. Rand had devoted considerable study. Mr. Rand's monograph on 'The Geology of Eastern Pennsylvania' is published in the *Reports of the Second Geological Survey* (Annual Report, 1886, Part IV.) and in the *Proceedings* of the Philadelphia Academy of Sciences.

THE New York State Museum received the following awards at the St. Louis Exposition: Four grand prizes for general exhibit in the education department, paleontology, salt products, gypsum. Six gold medals for general scientific publications, minerals and building stones, cement, salt, iron ore separator, electrical insulators. Eleven silver medals as follows: Four for salt exhibits; two for sandstone exhibit; one for each of the following collective exhibits: Geological maps, granite, iron ore, clay products. Three bronze medals for exhibits of marble, iron ore and plaster model of iron mine.

St. Louis University, the oldest university in the Louisiana Purchase territory, has been awarded three grand prizes at the St. Louis World's Fair, as follows: (1) for the general exhibit; (2) for original drawings in embryology by Professor A. C. Eycleshymer; (3) for twenty-five charts of topographical anatomy by Professor Peter Potter. Several gold and silver medals were also awarded.

As already announced, the fourth meeting of the American Philosophical Association will be held in Philadelphia, December 28–30, in affiliation with the American Psychological Association, the American Society of Naturalists and other societies convening with the American Association for the Advancement of Science. In accordance with a vote at the last meeting, arrangements have been made, in commemoration of the centenary of

the death of Kant, for a series of papers on 'Kant's present significance.' There will also be a paper in recognition of the bicentenary of the death of Locke. It is hoped that one session may be held conjointly with the Psychological Association. In addition to these special features, a full and varied program is assured by the large number of papers already offered.

The San Francisco section of the American Mathematical Society holds its meetings alternately at the University of California and Stanford University, in September and February, respectively. The next meeting will be held at Stanford University on February 25. Professor M. V. Haskell is president and Professor G. A. Miller, secretary of the section.

At the recent Princeton meeting of the Association of Teachers of Mathematics of the Middle States and Maryland, officers were elected as follows: *President,* Professor Thomas Scott Fiske, Columbia University; *vice-president,* Dean H. B. Fine, Princeton University; *secretary,* Arthur Schultze, High School of Commerce, New York City; *members of the council,* Professor Edwin S. Crawley, University of Pennsylvania, and Miss Jenny Van Vleck, Girls' High School, Brooklyn.

The American Society of Mechanical Engineers is meeting in New York this week. Mr. Ambrose Swasey, the retiring president, announced as the subject of his address 'The Achievements of the Engineer with respect to exact Measurements.' Mr. John R. Freeman, of Providence, R. I., has been nominated for president next year.

The opening meeting of the eighty-sixth session of the British Institution of Civil Engineers took place on November 1. Sir William White, the retiring president, took the chair at the opening of the meeting, and he was supported by Sir Guilford Molesworth, the incoming president, Sir Benjamin Baker, Sir William Preece, Professor Unwin, Colonel Crompton, Sir J. Wolfe Barry, Mr. Alexander Siemens, Dr. Kennedy, Sir Alexander Binnie, Mr. C. Hawksley, Mr. J. C. Hawkshaw, Dr. Elgar, Mr. Yarrow, Sir John Thornycroft, Sir George Bruce, Mr. R. A. Hadfield and Dr. Tudsbery (secretary).

The Ben Nevis Meteorological Observatories were closed on October 1, after having been in operation for nearly twenty-one years. The cost of the observatories and improvements was about $35,000 provided by subscription, and the annual cost of maintenance had been about $5,000, most of which was privately subscribed.

UNIVERSITY AND EDUCATIONAL NEWS.

The New York *Evening Post* states that Sir William Macdonald is perfecting his plans for the new agricultural college and experimental farm which, under the supervision of Professor Robertson, late of the Government Experimental Farm at Ottawa, he is to establish at St. Anne de Bellevue, near Montreal. About seven hundred acres of land have been secured by the founder, who declares that the college is a personal affair of his own, and that he does not intend to be bound down to any definite sum of money in the completion of his work. The erection of the buildings will be commenced next spring, and the whole cost is expected to be between one and two million dollars. The institution will be patterned after the agricultural college at Guelph, and the experimental farm at Ottawa.

The Oxford Congregation by a vote of 200 to 164 has rejected the proposal that in the entrance examinations candidates who are seeking honors in mathematics or natural science may be allowed to substitute French or German for Greek.

At a dinner of the Oxford Colonial Club, held on November 14, Lord Roseberry announced that the Rhodes Trustees, hearing that the university was in some danger, from want of the necessary means, of losing their present teacher of pathology, were prepared to contribute £200 a year for five years.

Dr. Leo Loeb has been appointed assistant professor of pathology at University of Pennsylvania.

Mr. R. G. D. Richardson has been appointed instructor in mathematics at Yale University.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 16, 1904.

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SOME PROBLEMS IN THE LIFE HISTORY OF PATHOGENIC MICROORGANISMS.[*]

OUR knowledge of the profound influence which the microscopic organisms, known as the bacteria, exercise in the life of the globe, may be considered an acquisition of the last quarter century. The surmises and hypotheses of the half century preceding were then made over into well-attested facts.

The activities of microorganisms manifest themselves in many different ways. The functions carried on by the bacteria of the soil are known to be of fundamental importance to higher plant life. The work of the bacteria producing fermentation, putrefaction and decay is of similar importance in preparing the way for the soil bacteria and ministering to the wants of higher organisms. Out of this latter class there has arisen a group which has given these microorganisms all the notoriety they possess. It is a small group, but formidable in that it is in partial opposition to the higher forms of vegetable and animal life. It is these parasitic forms to which I shall devote my address, as it is they which have preoccupied my attention for some years. In thus passing over large groups of bacteria I simply register my inability to properly present their claims, and I trust that others here present will fully supplement my paper by dealing with them in deserving fashion.

While bacteriology, strictly speaking,

[*] Address, Section Bacteriology, International Congress of Arts and Science, St. Louis, Mo., September 24, 1904.

deals only with a fairly well-defined group of unicellular plant-like forms standing near the limit of microscopic vision, medical bacteriology has been gradually widening its scope to a study of all unicellular and even higher parasitic forms, which multiply more or less indefinitely and continuously for a time in the invaded body. In addition to the bacteria proper, the protozoa, and those highly important ultramicroscopic organisms which seem to have certain characters not possessed by either of the other two groups, are now frequently gathered into medical bacteriology, because of certain underlying principles of action which they possess in common as parasites.

Bacteriology differs from the older sections of biology in several important particulars. In the first place, it has been developed under the stress of practical demands. The enormous economic and sanitary significance of bacterial life has pushed forward this study very rapidly, and the problems undertaken have been suggested almost wholly by considerations arising in agriculture and medical practise.

In the second place, bacteriology, at least so far as the parasitic forms are concerned, is essentially a study of two realms, that of the parasite and that of the host, of two organizations, widely different, acting upon one another and entering into complex, reciprocal relations. The older departments of biology do not present such a complicated aspect. Thus anatomy or morphology has, at least until very recently, dealt with structure and development without considering the relation of the individual to its environment. That was relegated to physiology and pathology. With the bacteria the morphologic aspect dropped nearly out of sight because of the difficulty encountered in analyzing structures so minute and relatively simple. Even the classification gradually evolved, as more and more forms were examined, is at present very largely a physiologic one, the characters being based on the action which the bacteria exert upon the medium in which they multiply.

Then again, there was no ulterior interest in the study of bacteria as such, which is a strong impulse in many other departments of biologic science. It is what bacteria do rather than what they are, that commanded attention, since our interest centers in the host rather than in the parasite. This tendency manifested itself in a peculiar way. As soon as bacteria could be handled in pure culture, the study prosecuted most actively was how most quickly to destroy them. Disinfection, sterilization and all agents which act destructively upon bacteria were diligently sought for. The first impulse of the youthful branch of bacteriology was thus to destroy, rather than to study and analyze. When, some years later, the antibodies were discovered, the rush toward the bactericidal serums was equally manifest.

Bacteriology in its scientific form was thus ushered into existence largely by medical men who had definite practical ends in view. It presented from its beginnings a dual aspect for study and its chief aim from the first was the destruction of one of the elements, the parasite. Slowly, however, the more impartial study of host and parasite in their mutual relation began to take root and to-day there is scarcely a department of physical, chemic and biologic science which does not have some share in the unfolding of this complex relation existing between plant and animal life, on the one hand, and the microorganisms acting as parasites, on the other. As a result of this rather unique state of affairs, bacteriology is not a self-contained, well-defined field of work, but one greatly subdivided by aims and methods of study. A realm as large as that of microorganisms

may well claim attention in many workshops of science.

The short time at my disposal does not permit a wide survey of the field of bacteriology, and I have deemed it best to discuss in a general way the parasitism of bacteria and to outline the probable results of any attempts of medical and sanitary science to modify this parasitism. In undertaking this task I have adopted the somewhat discredited method of presenting actual hypotheses, partly new, partly old, in a new dress. These furnish a definite point of attack, and are better suited for discussion than any presentation which boxed the compass with the views already well known.

Infectious diseases have frequently been portrayed as a battle between two organisms, the host, on the one hand, the parasite, on the other. There are few diseases even among those not strictly infectious in character in which this battle does not go on at some stage and in which the activity of bacteria may be ignored. For some years the analysis of this warfare has been the chief problem of bacteriology and pathology. What are the weapons of offense and defense on either side? Are the weapons simple or complex? Are they changed as the struggle progresses to suit the immediate state of the battle? Do the combatants themselves change during long or short periods of time, and does the character of the disease change as a consequence? Do the parasites act differently when posing for us in the culture tube than in the animal body? These and other queries may easily be read into the special literature of the last decade.

To realize the great complexity of this struggle we need but to review the gross facts of disease which express themselves in epidemics, on the one hand, in individual disease, on the other. We meet all gradations of severity, from rapid death to a mild transient disturbance, from a disease lasting hours to one lasting fifteen or twenty years, or even longer. Even the simplest generalizations concerning such a varied phenomenon must necessarily be subject to many exceptions, and perhaps gross inaccuracies. This is evident from the heated discussions which have been waged over the humoral and the cellular phenomena, the antitoxic and bactericidal forces of the blood and the phagocytic activities of certain cells, each party to the discussion claiming, at least for a time, that the opponent had no case. Though the brilliant researches of Metchnikoff and Ehrlich, and the fundamental discovery of Behring and Kitasato, have to a certain degree exposed the mechanism of warfare, the exposure is only fragmentary, and the hypothetic reconstructions based on it are leading as usual to further controversy. We do know that no two species of microorganisms carry on the warfare just alike, and that the same parasite finds a somewhat different situation in every host attacked. The problem of the immediate future is to determine where the brilliant discoveries of Metchnikoff, Nuttall, Behring, Bordet, Ehrlich and others belong in the life of each microbe, and to construct for each disease the exact nature of the contest.

In the following pages I do not intend to enter into any discussion concerning the intimate life of bacteria, but simply to point out certain biologic problems which seem to lie on the surface, as it were, and which illustrate the close relation existing between bacteriology and general biology. They have suggested themselves to me from the comparative standpoint, one up to the present but poorly cultivated in medical science.

The researches of Roux, Kitasato and Behring, Van Ermengen and others, have shown that certain species of bacteria secrete toxins during their vegetative period.

These toxins are soluble in the mediums in which these species multiply. Besides these physiologically well-defined poisons, there are others which are closely linked to the body substance of the bacteria, and which have become familiar to us in such well-known substances as tuberculin and mallein. According to the theory of R. Pfeiffer, this second class of poisons is liberated only by the disintegration of the bacteria, and the intoxication of the host, due to its destructive action on the bacilli, is a kind of post-mortem effect of the parasites. Other bodies, the so-called lysins, which act destructively upon red and white corpuscles, have also been demonstrated by Van de Velde and by Ehrlich and his pupils, but their significance in disease is not yet clear.

In the host, on the other hand, during the multiplication of microorganisms, there appear bodies known as antibodies, which have aroused the greatest interest. They neutralize the soluble toxins, agglutinate the invading bacteria and disintegrate them. They also precipitate or coagulate albuminous bodies. Their action is specific, being directed toward the invaders. These are the main weapons which thus far have been found. Are there other offensive and defensive bodies? What course do the bacteria pursue in the presence of the gradually accumulating antibodies of the host? Do they forge new weapons or not?

Professor W. H. Welch in his Huxley lecture presented the theory that the mechanism of the production of antibodies on the part of the invaded host was set in operation by the microorganisms as well, and that various tissue poisons might have their origin in overproduced bacterial receptors thrown off under special stimulation by host substances. This theory implies that bacteria may not unfold all their activities in the culture tube and that the latter give us no reliable clue as to their behavior in the living body.

On this point we may perhaps get some light by a consideration of the plasticity of microorganisms. It has long been known that the pathogenic power of bacteria is reduced gradually in artificial cultures. It is also well known that by a series of inoculations or passages through animals the virulence may be restored, and even raised above the natural level. Bacteria have been gradually accustomed to originally destructive doses of poisons in culture fluids. Very recently it has been shown that they may be gradually trained to multiply in strongly bactericidal serums and to refuse to be clumped in strongly agglutinating serums.

These adaptations persist for a certain time and are transmitted for a limited period, even in culture. In other words, the modifications are more or less gradually acquired and gradually lost. The same is true of the antibodies of the host. The antitoxin circulates in the blood of the horse long after the stimulation by toxins has ceased. In the immunized animal the agglutinating properties do not disappear at once. I am, therefore, inclined to believe that the bacterium freshly removed from its usual environment will, at least for a time, exercise all its functions, provided the special nutritive substances which may be needed to carry on those functions are present.

The theory of Professor Welch would then resolve itself into a question of nutrition. In the body of the host there are certain substances which give rise to special toxins when acted upon by special bacteria. If we could offer these special substances to freshly isolated bacteria there is no reason why the assumed toxin should not be formed. We must, therefore, take into account two possibilities, the adaptation of microbes to originally destructive agencies,

and the production of poisons from specific substances elaborated by the host.

I have entered into this much of detail concerning the mutual relation of microorganisms and host in order to make clear the hypothesis, which it seems to me accounts very well for the general phenomenon of infection. It is that the tendency of all invading microorganisms in their evolution toward a more highly parasitic state is to act solely on the defensive while securing opportunity for multiplication and escape to another host. By tendency I mean a general slow movement through long periods of time. The following data are in its favor:

1. The production of diffusible toxins survives parasitism indefinitely, and is readily brought about in cultures.

2. Where toxin-producing bacteria have become adapted to a definite species, as in diphtheria, the toxin itself acts upon a number of different species. In other words, the parasitic relation is far more specialized than the chief pathogenic product.

3. No strictly invasive bacteria have yet been found producing diffusible toxins which appear to be of any real significance in the disease process.

4. Those which produce such toxins are not strictly invasive bacteria.

5. The injury due to invasive bacteria is known to be due to the disintegration of bacteria and the setting free of poisons locked up in the bodies of the microbes.

6. Pathogenic bacteria manifest less biochemic activity than the related saprophytic forms.

7. The hemolytic and leukocidic toxins of bacterial filtrates may be due to autolysis of the bacteria. Jordan has shown that hemolysis is at least in part due to a change in the reaction of the culture fluid.

According to this hypothesis, microorganisms in slowly adapting themselves to the parasitic habit would gradually eliminate active toxin production and other aggressive weapons as of little use, and strengthen whatever defensive mechanisms they may accidentally possess the rudiments of. If these are capable of marked development, we may expect such types of disease as tuberculosis, leprosy, glanders and syphilis, in which the parasitic habit is carried to a high state of perfection. If their mechanisms of defense are not capable of much development they will soon be destroyed or else become adapted to live upon the skin, and especially the mucous membrane as opportunists and occasional disease producers.

In this adaptation the possession of somatic poisons set free during disintegration may play an important part. They may give rise to just sufficient toxin to produce a local protecting nidus of necrotic tissue, until the time for escape to some other host arrives. This assumption is supported by the fact that diseases of some duration are usually focal in character. The microorganisms multiply only in certain foci which sooner or later become evident as the visible seat of disease.

It may be claimed that defensive and offensive methods are practically the same, and that it is simply a play upon words to make any distinction between them. But reflection will convince us that offensive methods mean direct injury, whereas defensive methods simply mean a neutralization of the offensive weapons or else a condition which is invulnerable to them, such as an envelope made of a special substance.

According to Ehrlich and his pupils, the antibodies which appear in the course of disease are not new bodies, but overproductions of bodies present in minute quantities normally. The parasitic microbe is thus at the very beginning of the invasion confronted with these bodies. At the

termination of the disease there are no new bodies present, but the antibodies are on hand in relative abundance. The situation which the invader has to face is thus qualitatively the same at the beginning and at the end of the attack. How does he meet it by defensive methods?

Three possible fates await the invaders: (1) They are largely destroyed within the body; (2) they are excreted, or discharged through various channels; (3) they remain indefinitely in the body after the disease is over, to be eventually destroyed or eliminated.

That the microorganisms are largely destroyed within the body in the course of the disease is not open to dispute; this class is of no special significance to us. Of most importance are those that escape to continue their life cycle in another subject. The mechanism of elimination is of vital importance to the parasite. It assumes many forms, and is admirably adapted in the various specific diseases to perpetuate the existence of the species.

The survival of the microbes after the disease is over may be explained partly on the ground that in nearly all diseases some of the microbes pass their final stage near the surface of the skin, or mucous membrane, or in organs in direct or in indirect contact with the outer air, so that escape outward is readily effected through destruction of tissue, and hence protection from the bactericidal forces of living tissue. The small number which in some types of disease remain alive for some time after the disease process has subsided, may also be enclosed in small foci of necrotic tissue, and thus escape destruction temporarily.

I am inclined to believe, however, that among the problems of the future will be the elucidation of still another mechanism for the protection and escape of the microorganism. It is highly probable that in a certain number of species of bacteria after the active vegetative stage a latent stage follows, during which the parasite which has escaped destruction provides itself with some protective envelope which also aids it in its passage to a new host. This envelope, which may be some specific substance not recognizable with the microscope, or which may be represented by the capsules in some groups, may be a defensive body of the parasite stimulated to overproduction by the antibodies of the host. This body also interferes with the metabolism of the microbe and thus acts in the double capacity of stopping the disease and protecting the microbe at the same time. This hypothesis suggested itself to me while endeavoring to account for the peculiar behavior of tubercle bacilli under cultivation.

It is well known that tubercle bacilli from the diseased tissues of cattle grow very slowly, and then only upon certain culture mediums, such as blood-serum. After several years of continuous cultivation they multiply vigorously in glycerin bouillon and can hardly be distinguished in appearance from those human varieties of the bacillus which grow richly from the first or second transfer. There seemed to be no justification to assume that the bacillus had completely changed its metabolism under artificial cultivation. The more rational hypothesis seemed to be the one which assumed the existence of some protective substance only slightly acted upon by the serum, not at all in glycerin bouillon, and therefore a hindrance to multiplication. After repeated transfers, this protective substance was slowly lost either through a selection of bacilli or absence of stimulation on the part of the host, or both causes combined, and the growth became as luxuriant as with the more saprophytic human varieties. It is obvious that each group or species of bacteria would have its

own special protective device depending upon original capacities of the species which would be gradually developed in power and efficiency with the perfection of parasitic relations.

The formation of protective or defensive coverings, the strengthening or modification of the cell wall or the secretion of defensive fluids, would account for certain phenomena which are familiar to bacteriologists much better than the current theory which bases parasitism exclusively upon toxin production, active or passive.

In cultures we should expect a loss of power to form protective substances because the antibodies are absent. Hence the universal tendency toward the reduction and final loss of virulence, with apparently the metabolic and vegetative activities unchanged, and the frequently observed regaining of virulence by passages through series of animals.

In the evolution of parasitic bacteria I assume then that though the function of toxin production may have been the entering wedge toward a parasitic existence, there is a progressive loss of this function as of little use to the parasite after it has once acquired a foothold, for the action of toxins at a distance from the focus of multiplication does not aid the parasite, while it may destroy the host. In other words, with the invasion of the tissues of the latter it became necessary for the invader to concentrate its powers in its immediate vicinity, and for this purpose those poisons set free by the disintegration of the parasite may be of use in protecting the focus where the younger forms are, by necrosis of tissue, plugging of vessels, etc., and thereby keeping away the bactericidal forces until the bacteria have accumulated sufficient protective power to subsist in a latent condition and are ready to be discharged outward. With the loss of active toxin production according to this hypothesis and the loss of other, now useless, metabolic activities, there goes hand in hand a strengthening of the defensive functions. This strengthening I interpret as the gradual development of certain substances which the non-immune host is unable to act upon or at most only in a slight degree. This substance which, as it were, shoves itself between the parasite and the common bactericidal forces of the body, bears the specific pathogenic character of the microbe. It is the substance which, according to the nomenclature of Ehrlich, calls forth the amboceptor from the resources of the host to combine with it, and thus open the way for the usual bactericidal forces or complements according to Ehrlich. The existence of this specific protective body will account for the varied resistance of animals to the same microorganism and the relative difficulty to induce immunity. The more difficulty the body has in producing the amboceptor the greater the difficulty in acquiring immunity.

In the departments of preventive and therapeutic medicine, the isolation of this protective substance apart from the body toxins would be of prime importance in combating disease by inducing individual resistance. In fact, the theory that the so-called immunizing and disease-producing substances are separate is not new, but has been presented under various forms. The tendency to give up the toxic extracts of bacteria and use the latter in their entirety in immunization pays tribute to these unknown bodies. The most prominent example of this change was the abandonment by Koch of the old tuberculin, a boiled extract, and the utilization of the entire tubercle bacilli ground and uninjured by heat, in the production of immunity in tuberculosis.

The foregoing hypothesis, that the tendency of microbes in perfecting the parasitic habit is to act solely on the defensive, is to

a certain degree supported by a phenomenon of considerable biologic importance, which I wish to discuss very briefly.

If we examine the statistics of the various infectious diseases we are struck with the relatively low mortality of most of them. There are few highly fatal plagues now known. To be sure, the mortality of many infectious diseases is regarded as formidable by sanitarians, but if we disengage ourselves from the humane view for the moment and take the biologic standpoint, we will agree that the relatively high mortality of 25 per cent. to 50 per cent. indicates a very decided preponderance of the resisting powers of the human race. The odds are always against the invading microbe. This state of affairs appears for the moment to contradict the results of experimental bacteriology, which teach us that the virulence of microbes may be more or less rapidly raised by repeated passages through susceptible animals, or even through those which possess considerable resistance. The accustoming of bacteria to antiseptics, bactericidal and agglutinative serums, has already been mentioned. With this capacity for adapting themselves to the defensive mechanisms of the host, why should not the infectious diseases become more, rather than less, virulent? What is it that keeps their virulence on a low level? This problem has occupied my attention for a number of years, but only recently did a fairly satisfactory explanation present itself. Before entering upon it I have still one other phase of the problem to consider.

Of a given number of races of the same species of bacteria, the one which becomes parasitic on a given host species is not necessarily the most virulent for that species. This phenomenon impressed itself upon me during the study of a number of races of the bacillus of septicemia hemorrhagica, or, more familiarly, rabbit septicemia. Races of this species have been found very widely distributed among mammals and birds. Epizootics due to it have been described as occurring among cattle, carabao, game, swine, rabbits, guinea-pigs, fowls, geese, etc. It lives in the upper air passages of many domestic animals in health.

The rabbit may be successfully inoculated with any of these races. Some are very virulent, for the merest scratch of the skin inoculated with them will result in death within twenty-four hours. But the rabbit is not attacked spontaneously by them, although they are ubiquitous. The race which has fastened itself upon the rabbit is one of a very low degree of virulence for that animal. Similarly the highly virulent tubercle bacillus of cattle is encountered only occasionally in man, although the opportunities for a transfer from cattle to man are very good.

On first thought, it would seem to us that the most virulent race would be the one to crowd out any less virulent races and to finally predominate. But comparative pathology shows us that the contrary may be true.

The explanation for these apparently discordant facts readily flows from a consideration of the life history of parasitic microorganisms. This briefly consists of three phases, the entry into the host, the temporary multiplication therein, and lastly, the escape to another host. Each step in this life cycle must be carefully and deliberately worked out in the evolution of parasitic organisms, and each demands a special mechanism adapted to the purpose. One step is as important as the other. The parasite must find an unguarded entry or one which yields readily to its efforts. It must have a means of defense within the body and it must finally reach the exterior to enter a fresh subject.

As a result of these needs, each microorganism producing disease has one or sev-

eral avenues of entry and escape. In some of the protozoa there is but one avenue, and this is highly specialized and is through the body of some insect. Among the bacteria the channels of escape are less highly developed, and there may be several. As a rule, the microbe adapts itself eventually to a locus more or less in direct contact with the exterior, and in some instances the loci of entry, multiplication and exit have coincided. If we think over the various infectious diseases of man and animals, of which we have any definite information, we shall be surprised to find in how many the points of attack are in organs or tissues in direct communication with the exterior. In the most common type of tuberculosis, pulmonary consumption, the process is almost wholly limited to the respiratory organs. In typhoid fever the process is to a large degree carried on in the intestinal wall. In dysentery and cholera it is wholly so. Even in the very protracted disease of leprosy, the skin is the chief seat of the disease, while the discharge of bacilli from the ulcers of the nose is the rule in the tuberculous type. In that exquisitely parasitic, highly specialized group of microorganisms producing the eruptive diseases the final process is carried on in the skin. In these diseases the mechanism of escape is the most perfect.

On the other hand, among the spore-bearing pathogenic bacteria the means of escape is uncertain. Thus the anthrax bacillus betrays its saprophytic nature, as pointed out by Koch many years ago, in its inability to produce spores within the body. Were it not for the accidental discharges of blood from the mucous surfaces and the operations of man, the bacillus might not escape at all to sporulate. Similar conditions obtain for the bacillus of tetanus and of Rauschbrand. Both produce disease probably in an accidental manner and not as progressive parasites. Their continued existence is assured by vegetation and spore formation outside of the body, and it is highly probable that the species would continue to exist if they did not attack animal life, and that their incursions into the body are of no use to them. On the other hand, all attempts to demonstrate the production of spores in bacteria whose existence depends largely or wholly upon parasitism have thus far failed. The spore is evidently poorly fitted to parasitism and is replaced by other devices of more adaptability.

The mechanisms of invasion and escape bear a distinct relation to the pathogenic power or virulence. It is safe to assume that those varieties or species, no matter how virulent, will be eventually destroyed if these mechanisms are imperfect. In fact the more virulent the microbe, the more rapid the death as a result of invasion, the less the opportunity for escape. Hence there will be a selection in favor of those varieties which vegetate whence they can escape. The surviving varieties would gradually lose their highly virulent invasive qualities and adapt themselves more particularly to the conditions surrounding invasion and escape. That some such process of selection has been going on in the past seems the simplest explanation of the relatively low mortality of infectious diseases. These individuals or races of microbes which invaded the host too rapidly and caused death would be destroyed in favor of those which vegetated more slowly and in tissues permitting escape of the microbe after a certain time.

We may now return to the rabbit septicemia bacillus. The reason why the most virulent type of this group does not pass to rabbits is due to the fact that there is no satisfactory mechanism of entry and escape. This presupposes a lesion, a wound as a place of entry, and the excretion and

transfer into a wound in another animal. In the rabbit this difficulty is worked out in the way usual with this bacillus. The microbe adapts itself to vegetate upon the mucous membrane of the upper air passages. Under certain conditions it invades the lungs, pleural and pericardial, more rarely the peritoneal cavity, producing pneumonia and extensive exudates on the serous membranes, and causing death. The disease of the thoracic organs evidently follows some predisposing cause, which enables the bacillus to make a temporary invasion from the mucous membrane. This incursion into the body is not essential to the life of the race. In fact a little reflection will show that the bacteria which invaded are not likely to be transmitted, whereas those on the mucosa are readily handed down from old to young. The virulence of the bacillus is thus kept on a low level, so low that subcutaneous inoculation of pure cultures produces merely a local lesion. This type of disease is quite different from that produced by inoculation with highly virulent races. These multiply rapidly in the blood throughout the body.

We can now appreciate Pasteur's failure to exterminate the rabbits of Australia. He believed that with races of this bacillus on hand which destroy life very quickly, all that is necessary is to start the disease among rabbits, and it will tend to spread. The stricken rabbit with its blood full of germs does not offer the means for inoculating a second, and so the virulent race perishes.

We can understand, furthermore, why the bacteria associated with definite diseases in animals produce a diseased condition with difficulty after inoculation. The virulence of the specifically adapted microbe is of a relatively low order, and in the production of epizootics various conditions must be realized which assist the microorganism. The careful analysis of these conditions will form one of the great problems of pathology in the immediate future.

The phenomenon of the elimination of the most virulent races and the establishment of parasitic races of less invasive power I have portrayed in the simplest terms. But it is probably much more complex. The parasite, to be successful, must also stand in a definite relation to the tissue through which it enters. It is quite probable that the race of rabbit septicemia bacilli of high virulence would not be able to maintain itself in the mucus of the upper air passages. This ability to multiply in certain places is evidently an acquisition which gives the particular race its specific character. Without doubt the bovine tubercle bacillus, though of great virulence, does not possess the specific power of entering the human body, or it may be of maintaining itself after entry in certain tissues, such as the lymph-nodes, except under certain accidental, favoring conditions not yet understood. Perhaps the process of cultivating vaccine virus in the skin has deprived it of the capacity for entering through the respiratory tract, and has converted it into a purely inoculable virus.

In the study of pathogenic bacteria the relative ease with which pure cultures may be obtained from the blood and other organs only accessible by way of the blood has made this a favorite way of obtaining such cultures. But it may be asked whether we are not in this way obtaining bacteria of maximum virulence. May not the non-agglutinability of some typhoid bacilli immediately after isolation be accounted for in this way? In general, the bacteria thus obtained can differ but little from the type, as they are all recently descended from a single bacillus or a very few which caused the infection. It is different in the so-called passages through series of animals in which the usual portals

of entry and exit are circumvented and the bacteria injected into the body and withdrawn therefrom directly. As a result of such passages many species of bacteria have been made more virulent, and Pasteur was able to greatly modify the unknown virus of rabies.

Besides the maintenance of virulence and its occasional augmentation, a slow decline to complete loss of virulence may be looked for under conditions abnormal for the microbe. This probably goes on where the bacteria multiply, partly or wholly protected from bactericidal influences. The bacilli of tuberculosis, which multiply in cavities of the lungs or in muco-pus of the air-tubes in chronic cases, must be regarded as degenerating in virulence. And we actually encounter races varying considerably in pathogenic power. In the throats of well persons or those who had diphtheria months ago, bacilli without any power of toxin production, but with all the other characters of genuine diphtheria bacilli, are occasionally encountered.

During the elimination of the more virulent races of microorganisms, there goes on as well a gradual weeding out of the most susceptible hosts. In a state of nature in which medical science plays no part, there must occur a slight rise in the resistance of individuals, due to selection and perhaps acquired immunity, which meets the decline of virulence on the part of microbes until a certain norm or equilibrium between the two has been established. This equilibrium is different for every different species of microorganism, and is disturbed by any changes affecting the condition of the host or the means of transmission of the parasite. One result of the operation of this law is the low mortality of endemic as compared with epidemic diseases. Certain animal diseases, while confined to the enzootic territory, cause only occasional, sporadic disease, but as soon as they are carried beyond this territory, epizootics of high mortality may result. Climate in some cases enters as an important factor, but the most important, perhaps, is the slight elevation in virulence brought about by a more highly resistant host. The most susceptible animals are weeded out, and the rest strengthened by non-fatal attacks. The virulence of the microbe rises slightly to maintain the equilibrium. In passing into a hitherto unmolested territory, the disease rises to the level of an epizootic until an equilibrium has been established.

The same is true of human diseases, among which smallpox is a conspicuous example. The great pandemics of influenza, which seem to travel from east to west every one or two decades, soon give away to sporadic cases, and the careful work of many bacteriologists would indicate that the influenza bacilli found at present have fallen to the level of secondary invaders, and are parasites of the respiratory tract in many affections.

As pathogenic microorganisms differ not only in the degree of parasitism attained, but also in their essential nature, a great variety of diseases is the result. In a crude way they may be arranged into three classes:

1. Microorganisms which live upon the skin and the mucous membranes and invade the body only when lesions exist in these structures, or where the general resistance is impaired.

2. Microorganisms which appear only occasionally from some unknown but permanent focus. They produce epidemics often highly fatal, but they are successfully pushed back because the strain can not readily adapt itself to the new conditions.

3. Microorganisms which are most highly adapted for a parasitic existence and which produce diseases of a relatively fixed type.

As regards the first class, the conditions under which they produce disease rise more and more into prominence. The factor microbe becomes almost secondary to other factors. Many of our most common diseases obey certain meteorologic laws. Thus diphtheria and pneumonia are chiefly winter diseases, because the conditions of throat and lungs which favor them are largely due to cold weather, or we might say, the cold weather acting upon an indoor sedentary population or one subjected to untoward influences, injures the respiratory tract. Some microbes of this class depend upon the preparation made for them by others. Thus the exanthematous diseases, such as scarlatina and smallpox, are frequently associated with or followed by the invasion of streptococci, and the majority of deaths are due to such secondary invasion. The streptococci live upon the mucous membranes, and whenever the proper opportunity comes they invade more vital territory. This group of bacteria is the frequent cause of death in chronic diseases. Some years ago Professor Flexner pointed this out and denominated the invasion as a terminal infection. I think that they may also be appropriately styled the parasites of the diseased state.

Among the second group we may place such diseases as Asiatic cholera and the bubonic plague. The origin of the first is unknown. The definitive host of the second is probably the rat.

Among the third class we have such groups of diseases as tuberculosis, leprosy, syphilis and glanders, on the one hand, and the eruptive diseases, on the other. The former are very chronic, protracted, the widely separated but highly parasitic latter acute, rapid in their course. In the eruptive diseases the infection seems to depend solely upon the specific susceptibility of the individual, and immunity is easily brought about by protective inoculation.

In tuberculosis and leprosy the mode of infection is evidently very different from that of the group just mentioned. Prolonged exposure, as in family life, seems necessary to successful infection, and even then many exposed individuals escape. In tuberculosis, heredity plays a very prominent part in the eyes of the physician, because the disease appeared to propagate itself in families. This was probably due to the necessity for more intimate association and repeated exposure in order that the disease might appear. Here the disease is long drawn out, the parasite may become in a sense individualized, and the attack upon a new host may have to be made repeatedly. With these highly parasitic forms the necessity for a frequent transfer to another host is slight. In leprosy, the disease may last fifteen years to twenty years, and then death ensues, usually as a result of the attack of the secondary invaders.

From the biologic standpoint which I have endeavored to present, we may conceive of all highly pathogenic bacteria as incompletely adapted parasites, or parasites which have escaped from their customary environment into another in which they are struggling to adapt themselves, and to establish some equilibrium between themselves and their host. The less complete the adaptation, the more virulent the disease produced. The final outcome is a harmless parasitism or some well-established disease of little or no fatality, unless other parasites complicate the invasion. The logical inference to be drawn from the theory of a slowly progressive parasitism would be that in the long run mortality from infectious diseases would be greatly reduced through the operation of natural causes. But morbidity would not be diminished, possibly greatly increased, by the

wider and wider diffusion of these parasites, or potential disease producers. The few still highly mortal plagues would eventually settle down to sporadic infections or else disappear wholly because of adverse conditions to which they can not adapt themselves.

In this mutual adaptation of microorganism to host there is, however, nothing to hinder a rise in virulence in place of the gradual decline if proper conditions exist. In fact, it is not very difficult to furnish adequate explanations for the recrudescence and activities of many diseases today, though the natural tendencies are toward a decline in virulence. In the more or less rapid changes in our environment due to industrial and social movements the natural equilibrium between host and parasite established for a given climate, locality and race or nationality is often seriously disturbed and epidemics of hitherto sporadic diseases result. Typhoid fever will serve as one illustration of my thesis. It is ordinarily a sporadic infection, passing from the sick to the well by direct contact. Our knowledge that the infection of this and other diseases is contained in the discharges of the sick and a growing sense of cleanliness led years ago to the large systems of sewerage, which have made a crowded city life possible. But the removal of sewage from our immediate surroundings was the beginning of new trouble. The sewage was led into water courses from which drinking water came. Hence the great epidemics in place of sporadic disease. The direct transmission of the parasite on a small scale was largely checked, but the indirect transmission greatly favored. The dweller in cities with unprotected water-supply is still further endangered by the fact that the typhoid bacilli returned in the water may represent more virulent varieties than those handed down by his ancestors in rural communities. The motley population brought together by migrations from all parts of the globe bring the various races of bacilli with them to be redistributed on a large scale.

Conditions may even create diseases artificially. Thus in childbirth, the physician through want of cleanliness may in his examination actually inoculate a wounded surface with streptococci or other septic bacteria. In a hospital badly managed, such germs may be made to pass artificially through a series of individuals and their virulence raised. In nature this could not take place, because there would be no physician. Hence the transfer would not take place. The history of maternity hospitals before the period of asepsis in surgery is a sufficient proof for the theory advanced. Hospital erysipelas and hospital gangrene were diseases artificially bred. With the introduction of the principle of asepsis in medicine and surgery the artificially created diseases were destroyed, because the transportation facilities of the bacteria were cut off.

These illustrations indicate that so-called natural law does not stand in the way of our having highly virulent types of disease if we are ignorant enough to cultivate them. The microorganism is sufficiently plastic to shape itself for an upward as well as a downward movement. Among the most formidable of the obstacles toward a steady decline of mortality is the continual movement of individuals and masses from one part of the world to another, whereby the partly adapted parasites become planted as it were into new soil and the original equilibrium destroyed. These various races of disease germs become widely disseminated by so-called germ carriers, and epidemics here and there light up their unseen paths. Fortunately for us, the conditions under which these microorganisms may establish themselves are in

many cases so complex that they can not be realized. It is highly probable that the bubonic plague can not get a foothold or maintain itself among us, while Asiatic cholera might have a better chance, through our still greatly unsatisfactory water-supplies. Many tropical diseases would fail to take root in our climate. The mysterious rise and disappearance of leprosy in the middle ages has astonished many students of epidemiology. Possibly some slight bias of the microorganism may have accomplished what seems almost a miracle. Perhaps the right race or variety once introduced may repeat the history of the Middle Ages in our day or in that of the coming generation.

Another obstacle to the amelioration of infectious diseases is the rapid change going on in the habits of individuals and the ferment in our conceptions of health and well-being, which are continually upsetting any established equilibrium and making us more resistant to some diseases, more susceptible to others. Of great interest is the effect upon the human race of the assiduous care of those afflicted with certain chronic diseases which is just now expressing itself in the establishment of sanatoriums for the cure of the tuberculous. If this movement should gain great headway there may be a race of immunes gradually developed who may be able to stand the untoward conditions of indoor city life much better than the naturally robust and physically superior who have no so-called hereditary taint.

Of still greater interest is the vast vaccination experiment to whose beneficent influence the century just past bears ample testimony. The vaccinated individual is either wholly immune or else the disease contracted after exposure is abortive and the eruptive stage does not come to full development or maturity. The excretion of the infecting organism is thereby greatly interfered with and it is not improbable that in the mildest cases it may not reach that maturity necessary for the successful infection of others. In view of the adaptability of microorganisms in general, it is not beyond the range of possibility that a variety of the smallpox organism may through a chain of accidents arise as a result of successive passages through partly protected individuals. To-day it seems fairly well established that a single vaccination in infancy is not an adequate protection during life and at least one nation —a nation which not only cultivates but consistently utilizes science—prescribes two vaccinations as necessary to complete protection. Whether in the days of Jenner repeated vaccinations were deemed necessary I have not been able to verify; but we may assume without immediate fear of experimental contradiction that a century of incomplete protection may have worked some changes in the smallpox organism. In any case, it is obvious that our thesis implies in addition to the natural decline of virulence also a gradual rise in virulence whenever the resistance of susceptible individuals is raised on a very large scale. Either the microorganism if a true parasite will perish or else it will augment its invasive powers to meet those of its host.

Another problem has been created for the diphtheria bacillus by the extensive use of diphtheria antitoxin. Will the thorough protection of one group of human beings lead to the decline or to the increase in virulence of the diphtheria bacillus circulating among the individuals of this group? What effect will the transfer of such bacilli to unprotected groups have? These and similar queries may be answered not many years hence, for a generation of microbes represents a very short space of time.

It may not be out of place to call atten-

tion here to the bearing of my thesis upon the recent attempts to utilize parasitism in ridding us of undesirable or noxious animals. In bacteriology there have been attempts to destroy field mice and rats with certain species of bacteria. In entomology, parasitism is such a familiar phenomenon that it has been seized upon on a number of occasions to destroy otherwise unassailable insect pests.

Leaving out of consideration the presumptive dangers of introducing new species into a locality or country which must always be taken into consideration, although they may be of no significance, we have to consider the chances of success as compared with the cost of introducing and maintaining the parasites. In any event, we need not expect a destruction of the noxious species, for that is not the end of parasitism. A reduction in numbers is all that need be looked for. The new parasite will probably fail to become acclimated at first, and it may be necessary to reintroduce it for a number of years. During this period some few may become adapted to their environment and continue as parasites. Whether the equilibrium finally established will be of economic value, must be observed rather than predicted. In bacteriologic experiments of this kind the continued vigorous activity of the bacteria from year to year need hardly be expected. The disease will either die out or continue on a low level of mortality, in accordance with the general laws I have detailed, unless bacteria whose destructive powers are maintained and carefully gauged in the laboratory are distributed at definite intervals.

In conclusion, I will simply call attention to another problem affecting the future well-being of mankind, the possibility of new infectious diseases arising in the flux and change incidental to human progress. We have assumed that the capacity for a parasitic existence probably depends on some original offensive power of the microbe which it accidentally possessed, such as toxin production, or the presence of intracellular toxins combined with defensive powers. These, possessed independently of the host, were probably the entering wedges to be further developed or dropped, according to necessity. It is more than probable that all species of bacteria which possess these rudimentary invasive powers have already availed themselves of the opportunity to become parasites of animal life, on the one hand, of vegetable life, on the other, and that no startlingly new diseases will arise from saprophytic forms.

Subsidiary problems there are, however, concerning the modifications and readaptations of the parasitic forms already in existence. These may be grouped under two heads:

1. The transfer and adaptation of parasites from one host species to another.

2. The increase of invasive properties of parasites of the same host.

Are there any new diseases likely to appear as a result of the successful adaptation of parasites of higher animals to the human subject? This is a legitimate question, though difficult to discuss, for want of material at present. Among the more important possibilities I will simply mention the bovine tubercle bacillus and the hog cholera group of bacteria. The larger number of parasites on animals are so specialized, however, their receptor apparatus, according to Ehrlich, may have been so curtailed that parasitism on a relatively distant species may be impossible.

As regards the second problem, that microbes may gain in invasive power on the same host, the principle I have endeavored to establish would stand in the way of any rise in virulence because the most invasive forms of a varying species would have the

least chance for transmission. Whatever increase in disease-producing power may be acquired must be gained under special conditions, one of which is association with other microbes. Thus, if we could conceive of the same streptococcus, originally an inhabitant of the normal throat, as passing on account of some series of accidents through the bodies of a number of scarlatina patients, this streptococcus might thereby rise temporarily to the level of a serious menace to the throats and perhaps other organs of relatively healthy people.

Again, certain microbes like *B. coli*, the pneumococcus and meningococcus may, by living upon catarrhal mucous membranes and passed by case to case, acquire enough temporary pathogenic power to cause localized epidemics under favorable conditions. Any advantage thus gained would soon be sacrificed and the microbe return to the normal condition unless a satisfactory mechanism of transmission could be established.

It will be seen that there are many problems before the bacteriologist, problems which have something akin to those of the student of races, varieties and species among higher forms of life. These problems must be attacked with the same patience and pertinacity that were exercised by Mendel, Darwin, De Vries and many others in the effort to trace the rise of new species.

In dealing with the great problems of pathogenesis and parasitism as applied to the microorganisms in such a summary and hasty manner, and in endeavoring to trace the law of a declining virulence (and hence mortality) and an advancing parasitism, I may have left some doubts in the reader's mind concerning the ultimate value of medicine, preventive and curative, in controlling these diseases, since it might be assumed, according to the hypotheses presented, that they would take care of themselves. This impression will, I think, be dispelled by a little further development of the ideas presented.

The social and industrial development of the human race is continually leading to disturbances of equilibrium in nature, one of whose direct or indirect manifestations is augmentation of disease. In order to avoid this calamity or reduce its force as much as possible we must make special compensations or sacrifices to restore or maintain the normal balance. The more clearly the kind of compensatory action required is foreseen, the more promptly it is put into effect, the less disease there will be. It is the true function of medical science to discover and put into effect those compensatory movements which will counterbalance the temporary ill effects of what, for want of a more illuminating term, we call human progress.

It is largely through the phenomenon of parasitism that nature attempts to restore the equilibrium, and in this microorganisms play the most important part. As soon as the individual falls below a certain level he may become the prey of a microscopic, or even an ultramicroscopic, world. Hence the importance of bacteriology in medical science. Much has already been done in determining ways and means for the counterbalancing of the ravages of this microscopic world, but science can not rise above natural law, but must work through it. The optimism of the world frequently places science above natural law and believes it capable of correcting any and all excesses of individuals and races. We may be certain that it will never be able to eliminate the factor of parasitism. Its most important work will continue to be to analyze this factor into its minutest details and to devise means by which this analysis may be made useful in turning aside or at least in deadening the shock of disease.

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SCIENTIFIC BOOKS.

POINCARÉ'S 'SCIENCE AND HYPOTHESIS.'

La Science et l'Hypothèse. Par H. POINCARÉ, Membre de l'Institut. Paris, 1903. Pp. 284.

Wissenschaft und Hypothese. H. POINCARÉ. Autorisierte deutsche Ausgabe, mit erläuterenden Anmerkungen, von F. und L. LINDEMANN. Leipzig, 1904. Pp. xvi + 342; the notes, pp. 245–333.

A work from the pen of one of the distinguished savants who have so recently been the guests of the American scientific public is doubly interesting at the present time. Among the several domains of pure and applied mathematics which M. Poincaré has enriched by his researches, not the least important is that of the fundamental concepts and logical development of various branches of science. Like its predecessors, the work under consideration here is remarkable for the clear, incisive and succinct fashion in which it deals with the difficult and elusive problems lying at the foundation of mathematical knowledge.

The work is divided into four parts, preceded by a short introduction, *viz.:* First Part: 'Number and Magnitude,' pp. 9–48. Second Part: 'Space,' pp. 49–109. Third Part: 'Force,' pp. 110–166. Fourth Part: 'Nature,' pp. 167–281.

The first chapter is entitled, 'On the Nature of the Reasoning of Mathematics.' At the very outset, even the existence of the science of mathematics seems to present an irreconcilable contradiction. If mathematics is deductive, drawing all its conclusions strictly from their antecedent premises, how can it be more than a huge tautology? How are all the ponderous tomes of mathematical theory aught else than devious ways of saying *A* is *A*? If, on the other hand, the conclusions of mathematics say more than their antecedent premises, how is the unquestioned perfect rigor of mathematics maintained?

M. Poincaré finds the answer to these questions in the so-called 'mathematical induction' which proceeds from the particular to the more general, but at the same time does so by steps of the highest degree of certitude. In this process he sees the creative force of mathematics, which leads to real proofs and not mere sterile verifications. The illustrations used to make the thought clear are taken from the beginnings of arithmetic, where mathematical thought has remained least elaborated and uncomplicated by the difficult questions related to the notion of space. In successive instances it is shown how more general results are obtained from fundamental definitions and from previous results by means of mathematical induction. In each case the advance is made by virtue of that "power of the mind which knows that it can conceive of the indefinite repetition of the same act as soon as this act is at all possible. The mind has a direct intuition of this power and experience gives only the opportunity to use it and to become conscious of it" (pp. 23–4).

The conviction that the method of mathematical induction is valid our author regards as truly an *à priori* synthetic judgment; the mind can not tolerate nor conceive its contradictory and could not even draw any theoretic consequences from the assumption of the contradictory. No arithmetic could be built up, rejecting the axiom of mathematical induction, as the non-Euclidean geometries have been built up, rejecting the postulate of Euclid.

The second chapter terminates the first part and is entitled, 'Mathematical Magnitude and Experience.' It deals with irrational numbers and the creation of the mathematical continuum, concluding that 'this notion has been created by the mind, but that experience furnished the occasion' (p. 35). "The mind has the power of creating symbols, and by this means it has constructed the mathematical continuum which is merely a particular system of symbols. This power is limited only by the necessity of avoiding contradiction, but the mind makes use of it only when experience furnishes the warrant" (p. 40).

The second part, devoted to 'Space,' consists of chapters on 'The non-Euclidean Geometries,' 'Space and Geometry' and 'Experience and Geometry.'

In this part the fundamental question is: What is the nature of the axioms of geometry? Our author's views may be seen in the following quotations:

The axioms of geometry are neither synthetic judgments à priori, nor experimental facts. They are *conventions:* our choice among all possible conventions is *guided* by experimental facts, but it remains *free* and is limited only by the necessity of avoiding all contradiction. Hence the postulates can remain *rigorously* true even though the experimental laws which have determined their adoption are only approximative.

In other words, *the axioms of geometry* (I am not speaking of those of arithmetic) *are merely disguised definitions.* Consequently the question: 'Is Euclidean geometry true?' has no meaning. As well ask whether the metric system is true and the old measures false, whether Cartesian coordinates are true and polar coordinates false. One geometry can not be more true than another, it can only be *more convenient.*

Euclidean geometry is and will remain the most convenient:

1. Because it is the simplest; and it is so not only in consequence of our mental habits, or of I know not what direct intuition we may have of Euclidean space, but it is the simplest in itself, just as a polynomial of the first degree is simpler than one of the second.

2. Because it accords well with the properties of natural solids.

Beings with minds and senses like ours, but who had received no previous education, might receive, from an external world suitably chosen, impressions such that they would be led to construct a geometry other than that of Euclid and to localize the phenomena of that external world in a non-Euclidean space, or even in a space of four dimensions.

If, on the other hand, we whose education has been received in our actual world were suddenly transported into this new world, we should have no difficulty in relating its phenomena to our Euclidean space (pp. 66–8).

If the geometry of Lobatscheffsky is true, the parallax of a very distant star would be finite; if that of Riemann is true, it would be negative. These are results which seem within the reach of experiment, and there have been hopes that astronomical observations might enable us to decide between the three geometries.

But in astronomy 'straight line' means simply 'path of a luminous ray.'. If, to suppose the impossible, negative parallaxes were found, or if it were demonstrated that all parallaxes are superior to a certain limit, two courses would be open; either we could renounce Euclidean geometry, or we could modify the laws of optics and admit that light does not travel rigorously in a straight line. It is useless to add, that every one would regard the latter as the more advantageous, Euclidean geometry has nothing to fear from new experiments (p. 93). "No experience will ever contradict the postulate of Euclid, nor will any ever contradict that of Lobatscheffsky" (p. 95).

The third part, devoted to force, consists of chapters dealing with 'Classic mechanics,' 'Relative movement and absolute movement' and 'Energy and thermodynamics.'

Here, as in geometry, our author finds that the fundamental principles are neither *à priori* truths nor experimental facts but convenient definitions or conventions.

If the principle of inertia, for example, were an *à priori* truth, how could the Greeks believe that movement ceases as soon as the cause which originated it ceases to act? How could they believe that every body free from constraint would move in a circle, the noblest of all motions?

Is there any more warrant to say that the velocity of a body can not change without cause for the change, than that it can not change its position or the curvature of its path except under the influence of an exterior cause?

Have any experiments ever been made on a body subject to no force, and if so how was it known that no force was acting? A sphere rolling on a marble table for a very long time is a usual example, but has the force of gravity ceased to act?

Can the law that *the acceleration of a body equals the force acting on it divided by its mass* be verified experimentally? To do so the acceleration, the force and the mass must be measured. If we overlook the difficulties connected with the measurement of time, it may be granted that the acceleration can be measured, but there are inextricable difficulties in the definition of *mass* and *force.* Useful definitions must teach how to *measure* mass and force, and require definition of the

equality of two forces, and this implies the principle of the equality of action and reaction. "Hence, this principle should no longer be regarded as an experimental law, but as a definition" (p. 122). The result reached is that the 'law of Newton' as to acceleration must be regarded as a definition, in which *mass* is still undefined. "We are driven to the following definition, which is simply an avowal of impotence: *Masses are coefficients which it is convenient to introduce into calculations*" (p. 127).

While the principles of dynamics are definitions, they can be approximately verified by experiment. A more precise experiment would show simply that the law was only approximately true in that case; which we knew already. Thus we see how experience has served as basis for the principles of mechanics and still can never contradict it.

The analogy between geometry and mechanics would at first glance seem complete. In each the fundamental principles are merely conventions which experience has led us to set up as convenient. But there is a difference. The laws of geometry are set up in consequence of experiments in mechanics, in optics, in physiology; they are in no sense experiments in geometry; they do not relate to space (which geometry studies), but to material objects. On the other hand, the fundamental conventions of mechanics and the experiences which show that they are convenient, relate to the very same objects or to analogous objects. This is not an artificial barrier between sciences but a real distinction. The teaching of mechanics should, therefore, remain objective, experimental.

The fourth part, devoted to 'Force,' contains chapters on: 'Hypotheses in physics'; 'The theories of modern physics'; 'The theory of probabilities, optics and electricity,' and 'Thermodynamics.' In this part the relation of observation to hypotheses and generalization is taken up. Experience is the sole source of truth, but one must use his observations; he must generalize. A mere accumulation of facts is no more a science than a pile of stones is a house. Above all, the scientist must foresee. A good experiment teaches more than an isolated fact; it permits us to foresee, *i. e.*, it permits us to generalize. Interpolation is necessary. Experiments give us only a certain number of isolated points; generalization traces a curve. This curve does not pass exactly through all the points given by experiment. We not merely generalize experience, but correct it. Experimental physics furnishes the facts; mathematical physics orders them, makes the generalizations and points out the needs. In this generalization the unity of nature and the simplicity of its laws is presupposed. The curve does not follow all the zigzags indicated by the points given by experiment. Nevertheless, it is not certain that nature is simple, but generalization, and with it science, could not exist if the hypothesis of simplicity were entirely abandoned.

Generalization requires hypotheses. There are three categories of hypothesis: (1) Those which are natural and which can hardly be avoided, as that the influence of very distant bodies is negligible; (2) those that are indifferent, as that matter is continuous or that it is composed of atoms. These indifferent hypotheses are never dangerous, provided their true character is recognized. The hypotheses of the *third* category are true generalizations which experience should either confirm or invalidate.

The hypotheses of physics lead to physical theories which, though apparently well established, are in turn displaced by others. Various examples are discussed.

> "No theory seemed more solid than that of Fresnel which attributed light to movements of ether. But now that of Maxwell is preferred. Does this mean that the work of Fresnel was in vain? No, because the real aim of Fresnel was not to find out whether there really is ether, whether it is or is not formed of atoms, whether these atoms really move in this or that sense; his object was to foresee optical phenomena.
>
> Now the theory of Fresnel always permits this, to-day as well as before Maxwell. The differential equations are always true; they can always be integrated by the same procedure and the results always retain their value.
>
> Let no one say that thus we reduce physical

theories to the rôle of mere practical recipes; these equations express relations, and if the equations remain true it is because these relations preserve their reality. They teach us, now as then, that there is such a relation between such a thing and such another thing; only this something which formerly we called *movement* we now call *electric current*. But these appellations were only images substituted for the real objects which nature will eternally hide from us. The veritable relations between these real objects are the only reality that we can attain, and the only condition is that the same relations exist between the objects as between the images by which we are forced to replace them. If these relations are known to us, what matter if we deem it convenient to replace one image by another.

That some periodic phenomena (an electric oscillation, for example) is really due to the vibration of some atom which, acting like a pendulum really moves in this or that sense, is neither certain nor interesting. But that between electric oscillation, the movement of the pendulum and all periodic phenomena there exists a close relationship which corresponds to a profound reality; that this relationship, this similitude or rather this parallelism extends into details; that it is a consequence of more general principles, that of energy and that of least action, this is what we can affirm; this is the truth which will always remain the same under all the garbs in which we may deem it useful to deck it out" (pp. 189–191).

Our author has thus discussed the question of the degree of reality in various branches of science from four points of view. In arithmetic we have necessary truth developed *à priori* in the mind; in geometry we have to do with conventions, conveniently related to the material world, but not themselves amenable to direct experimental treatment; in mechanics we have likewise to do with conventions, but they are amenable to direct experiments; while in physical sciences we seek under various images to express relations which are profound realities.

It is impossible to give a summary of a work which is itself so summary. What precedes is an inadequate attempt to present a few characteristic views which may serve to indicate the general spirit of the work and the style of treatment. The larger part of the rich mass of material has necessarily remained untouched.

The work is characterized throughout by masterly clearness and by the skill with which the overgrowth of unessentials and consequences is stripped off and the fundamental idea presented in a few phrases. In its tone, the work addresses the non-scientist. Little technical knowledge is requisite to read it, but still it will hardly prove inviting to those who have not in some way attained a certain facility in following strict reasoning. To these it will furnish an excellent and stimulating discussion of some fundamental principles of modern science apart from the technicalities, while the scientist will welcome this presentation in connected form of carefully thought out views which have already aroused much interest in their earlier publication in various journals.

The work is also remarkable for the ease and directness of its style and for the genial manner in which the illustrative examples are chosen and treated. M. Poincaré is a past master of that most difficult art of giving the central thought of a large theory in a few words without sacrificing lucidity.

It is to be hoped that the work will receive in America that wide and thoughtful reading which it deserves equally on account of the subjects treated and the stimulating originality of the treatment. An English translation of the book and of the notes of Lindemann is a desideratum.

Of the German translation little need be said. It is faithful and quite close, and acquits itself remarkably well of the difficult task of conveying the delicate and precise thoughts of the author into the German tongue. The task was of course much facilitated by the remarkable clearness of the original, in which there is seldom opportunity to question just what is meant, though the domain is one where few can avoid involved ideas and entangling phraseology. The imperative requirement that every shade of meaning be faithfully reproduced effectually restrains the translator from any of those paraphrases which must be permitted if the translation is to conform itself, unhampered, to

the genius of the language. In view of these restrictions, the translation seems good, but of course, other things being equal, preference will be given to the original.

A few points of detail may be mentioned: Page 9, lines 3 and 4 should read: '. . . dass er auch für $a = a + 1$ gilt, wenn er für $a = a$ richtig ist.' Lines 8 and 9 analogously.

Page 91, the essential phrase, 'ce qui est expérience, ce qui est raisonnement mathématique' (p. 111 of original) has not been translated.

Page 92, line 2, read 'ist' instead of 'wäre.'

The original, pp. 31 *et seq.*, ascribes to Kronecker that definition of number (as a partition of all rational number into two sets) which is commonly known as Dedekind's. The translation renders all these passages impersonally, and a note calls the presentation of the text Dedekind's, as modified by Tannery.

The notes added to the translation have decided value of their own, and make it desirable either to own both editions or on their account to give the translation the preference. They are to a considerable extent bibliographic, giving excellent lists of references to other works, many of them classic, on the numerous topics which come up. In this respect alone, the notes constitute a welcome and useful supplement to the original work, which makes citations only in the most general way with almost no specific references. But they also develop in many instances mathematical treatment of points touched on in the original, which contains practically no such matter. Frequently the notes state briefly the views of others on the topic in hand, or sketch its historical development, usually with detailed references.

A good index and a fuller table of contents have been added in the German edition.

J. W. A. YOUNG.

THE UNIVERSITY OF CHICAGO,
October 17, 1904.

THE NEW SEISMOLOGY.*

IN the old seismology the only earthquake tremors studied were those of sensible magnitude, and the records related chiefly to destructive effects. The earliest philosophy of the subject regarded the tremor chiefly as a cause, ascribing to it various geologic results, such as the uplifting of coasts and the eruption of volcanoes; and only by slow degrees did it come to be recognized as an effect, the jar communicated by subterranean rending. The new seismology employs instruments of the most delicate and sensitive character, and by their aid not only detects tremors far too faint for direct perception, but undertakes to measure in absolute terms the amplitude, period and speed of the waves and the intensity of the shocks. Its analysis discriminates earth waves of four different kinds, classifies shocks according to origin as volcanic or tectonic, and by means of its data discusses the physical condition of the earth's interior. In a volume recently issued Dutton sets forth the present condition of the science, sketching its history in outline, describing its instruments and characterizing its progress toward the solution of its more important problems. The treatise is well balanced, compact and as comprehensive as consists with adaptation to the needs of the general reader. Technicalities are avoided so far as practicable, and details are introduced only for the purpose of illustrating principles. While it does not neglect that aspect of the subject which falls within the domain of mechanics, and properly gives a major share of space to the treatment of tremors as elastic waves, it is especially strong in its discussion of the bearing of seismology on geophysics. Fortunately for the geologic as well as the general reader, the author brought to his task not only the experience acquired in monographing the Charleston earthquake, but the mental equipment resulting from prolonged study of volcanism and the greater problems of the inner earth.

The discovered blemishes of the book consist of occasional lapses, either of statement or of correlation between text and illustration. For example, the symbol a (page 175), which stands for the intensity of a shock at unit

* 'Earthquakes in the Light of the New Seismology,' by Clarence Edward Dutton, Major U. S. A. [No. 14 of The Science Series.] New York, G. P. Putman's Sons; London, John Murray, 1904.

distance from its origin or centrum, is erroneously defined as 'the intensity at the epicenter'; and the diagram on page 186 indicates the intensity of a shock in the locus technically called the pleistoseist as about four ninths of its intensity at the epicenter, whereas the text shows the ratio to be three fourths. Slips of this character, which might have been eliminated by more careful revision of copy and proof, will doubtless be avoided in subsequent editions. They detract but slightly from the general value of the work, which may be commended to the public as a lucid, attractive, and at the same time scientific presentation of a subject so difficult that its modern aspect is little understood outside the circle of its special students.

G. K. Gilbert.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for October has papers on 'The Anatomy of the Coniferales' (concluding article), by D. P. Penhallow; 'Studies of the Plant Cell, IV.,' by B. M. Davis, and 'The Affinities of the Ophioglossaceæ and Marsiliaceæ,' by D. H. Campbell.

The Popular Science Monthly for December contains the following articles: 'The Reclamation Service,' by F. H. Newell (deals with the problems of irrigating the arid regions of the west); 'Chinese and Japanese Immigration,' by Allan McLaughlin; 'The Status of American College Professors,' by John J. Stevenson; 'A Decade of Library Progress in America,' by William W. Bishop; 'Nature's Hieroglyphics,' by Richard S. Lull (treats of the fossil footprints of the Connecticut Valley); 'The Present Problems of Physiological Chemistry,' by R. H. Chittenden; 'The Agricultural Distribution of Immigrants,' by Robert DeC. Ward; 'The Conceptions and Methods of Psychology,' by J. McKeen Cattell. There are also shorter articles and notes on the progress of science, the latter including the two hundredth anniversary of the death of Locke and the two hundred and fiftieth anniversary of Columbia University.

The American Museum Journal for October is devoted mainly to an extensive and fully illustrated paper by W. Beutenmüller on 'The Insect-Galls of the Vicinity of New York City.' It also contains many notes relating to the progress of the museum in adding to or installing its collections. The number contains the index to the volume for 1904.

The Museums Journal of Great Britain has articles on 'A Simple Method of Drilling Glass,' 'The Museum Conference at Warrington,' 'The Hankfield Museum, Halifax,' and many notes from various museums. There is an instalment of the museum's directory of Great Britain which brings the matter down to Manchester.

Bird Lore for November–December contains articles on 'How to Study a Bird,' by Ernest Thompson. Seton; 'Some Familiar Florida Birds,' by F. W. Roe; 'Bird Life of a Swiss City,' by Wendell Prime; and 'Young Flamingos,' by Frank M. Chapman. There is the seventh paper on 'The Migration of Warblers,' by W. W. Cooke; 'Bird Lore's Christmas Census' and Notes, Reviews, Editorials and the very full Audubon Department.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

The American Association for the Advancement of Science, the American Society of Naturalists and the following societies will meet at Philadelphia, Pa., during the week beginning December 24, 1904:

The American Association for the Advancement of Science.—The week beginning on December 27. President, Professor W. G. Farlow; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, President Charles S. Howe, Case School, Cleveland, Ohio; secretary of the council, Professor Clarence A. Waldo, Purdue University, Lafayette, Ind.

Local Executive Committee.—President, Provost Charles C. Harrison; vice-president, Professor Edgar F. Smith; secretary, Dr. Philip P. Calvert; treasurer, Dr. Samuel G. Dixon; chairman of the executive committee, Provost Charles C. Harrison; of the committee on reception and entertainment, Mrs. Charles C. Harrison; of the committee on hotels and boarding houses, Professor Amos P. Brown; of the committee on meeting places and

equipment, Professor Edwin G. Conklin; of the committee on press and printing, Mr. George E. Nitzsche; of the committee on transportation, Mr. Walter Wood; of the committee on finance, Mr. S. F. Houston.

Section A, Mathematics and Astronomy.—Vice-president, Professor Alexander Ziwet, University of Michigan; Secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Wm. F. Magie, Princeton University; Secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Leonard P. Kinnicutt, Polytechnic Institute, Worcester, Mass.; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor David S. Jacobus, Stevens Institute, Hoboken, N. J.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Eugene A. Smith, University of Alabama; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Dr. C. Hart Merriam, U. S. Dept. of Agriculture; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Professor B. L. Robinson, Harvard University; Secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. Walter Hough, U. S. National Museum; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Vice-president, Martin A. Knapp, U. S. Interstate Commerce Commission, Washington; Secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor H. P. Bowditch, Harvard University.

The American Society of Naturalists.—December 27, 28. President, Professor E. L. Mark, Harvard University; secretary, Dr. Chas. B. Davenport, Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y.

The Astronomical and Astrophysical Society of America.—December 28, 29. President, Professor Simon Newcomb; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 30. President, Professor Arthur G. Webster; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 28–31. President, Professor Arthur A. Noyes, Massachusetts Institute of Technology; Secretary, Professor William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 29–31. President, Professor J. C. Branner, Stanford University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Botanical Society of America.—December 27–31. President, F. V. Coville; secretary, Dr. D. T. MacDougal, N. Y. Botanical Garden, Bronx Park, New York City.

The Society for Plant Morphology and Physiology.—December 28, 29, 30. President, Dr. G. T. Moore, Department of Agriculture, Washington; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

The Botanical Club of the Association.

The Fern Chapter.

Sullivant Moss Chapter.

Wild Flower Preservation Society of America.

The Society for Horticultural Science.—December 27. President, Professor L. H. Bailey, Cornell University; secretary, S. A. Beach, Geneva, N. Y.

The Society for the Promotion of Agricultural Science.—December 26. Secretary, Professor F. M. Webster, University of Illinois, Urbana, Ill.

The Association of Plant and Animal Breeders.

The Association of Economic Entomologists.—President, Professor A. L. Quaintance, Washington, D. C.; secretary, Professor H. E. Summers, Ames, Iowa.

The Entomological Club of the Association.

The American Society of Zoologists (Eastern Branch).—December 27, 28. President, Professor E. A. Andrews, Johns Hopkins University; secretary, Professor Gilman A. Drew, University of Maine.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor H. F. Osborn, Columbia University; secretary, Dr. O. P. Hay, American Museum of Natural History, New York City.

The Society of American Bacteriologists.—President, Professor F. G. Novy, University of Michigan; secretary, Professor F. P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December

27, 28. President, Professor R. H. Chittenden, Yale University; secretary, Professor Lafayette B. Mendel, New Haven.

The Association of American Anatomists. December 26, 27, 28. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

American Folk-Lore Society.

The American Anthropological Association.—December 27–Jan. 2. President, Dr. W J McGee, Washington; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Psychological Association.—December 28, 29. President, Professor William James, Harvard University; secretary, Professor Livingston Farrand, Columbia University, New York City.

The American Philosophical Association.—December 28, 29, 30. President, Professor George T. Ladd, Yale University; secretary, Professor H. N. Gardiner, Northampton, Mass.

The Sigma Xi Honorary Scientific Society.—President, Professor S. W. Williston, University of Chicago; secretary, Professor Edwin S. Crawley, University of Pennsylvania, Philadelphia, Pa.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

The 391st regular meeting was held Saturday evening, November 19, 1904. In response to the call for brief notes, B. W. Evermann spoke of the abundance of waterfowl at Lake Maxinkuckee, Ind., on or about November 5, 1904. At that time there were estimated to be on the lake 10,000 coots, 2,500 ducks, including at least 500 canvas backs, 100 to 125 brant and 36 swans.

Dr. E. L. Greene presented a paper entitled 'A Chapter in the Evolution of Generic Nomenclature.' A retrospect over the rise, gradual prevalence and subsequent exclusion from nomenclature of generic names in botany formed by the mere adding of *oides* to the name of an already established genus. For example, the sixteenth century name for the genus *Carex* was *Cyperoides*, for *Festuca* it was *Bromoides*, for *Phaca*, *Astragaloides*; and in the course of the half-century preceding the year 1753 there were taxonomists of excellent standing, like Vaillant, Micheli and Scheuchzer, with whom it seemed to be the rule to construct new generic names in this cheap and easy fashion. There were something like one hundred and fifty or, perhaps, nearer two hundred of these *oides* names prevalent in about the year 1740. At this juncture Linnæus, as if feeling that this kind of name-making was already carried *ad nauseum*, proposed in the 'Philosophia Botanica' that all *oides* names be rejected from plant nomenclature; and in both his 'Genera' and 'Species' he boldly carried the proposal into effect. In this he must have had the full sympathy of almost the whole body of the botanists of that time, for they followed his lead promptly. Only Adanson, whose feeling for Linnæus was bitter, had the hardihood to restore a few of the discredited *oides* names. From 1753 to 1893, not one of the great makers of modern botany adopted an *oides* name.

Unfortunately, by a too ready following of Dr. Otto Kuntze, a few *oides* names, after their long banishment from all botany, have reappeared in American books. In such books *Nicandra* has given place to the earlier *Physaloides*, *Nemopanthes* to *Ilicoides*, *Corydalis* to *Capnoides*, and *Luzula* to *Juncoides*. And so there has begun what seems to be the inauguration of another epoch of this kind of degeneracy in nomenclature. For if *Juncoides* be permitted to stand in place of *Luzula*, other such onomastic deformities will be justified, and what is worse, novices will be found who will take pride in coining new generic names on that very model long ago discredited, and these names will have to be admitted as valid.

In a communication entitled 'A New Seed-bearing Fern,' David White laid before the society specimens and drawings of the sterile fronds and seeds of a new species of *Aneimites*, *A. fertilis*, from the lower Pottsville of southern West Virginia. The genus *Aneimites*, better known under the name *Adiantites*, constitutes the third group of filicoid plants to reveal a seed fructification. It is, therefore, to be referred to the 'Cycadofilices' (Pteridospermeæ), though on account of its typically filicate fronds its fern nature, in the absence of all knowledge respecting its fructification, has hitherto been unquestioned.

Wilfred H. Osgood,
Secretary.

AMERICAN CHEMICAL SOCIETY.

NEW YORK SECTION.

A REGULAR meeting of the section was held at the Chemists' Club, Friday evening, November 11.

Dr. Hugo Schweitzer introduced the following resolution, which was seconded by Mr. T. J. Parker:

The speedy introduction of the metric system of weights and measures by appropriate laws is most desirable in order to rid our country of a most illogical and cumbersome system, which is one of the greatest obstacles to the development of our export trade, and in order to place our country on a parity with other great manufacturing countries.

After some discussion by Messrs. Peckham, Schweitzer and Parker, the resolution was adopted without dissenting vote.

The regular program was then taken up and the following papers read:

The Determination of Ammonia in Milk. H. C. SHERMAN and W. N. BERG.

This paper summarized the work thus far accomplished, the preliminary results of which were presented at the Providence meeting in June, 1904.

The Boussingault-Shaffer method (slightly modified) in which the sample is mixed with methyl alcohol, made alkaline with sodium carbonate and distilled under diminished pressure, had been found to be sufficiently delicate for the determination of ammonia in milk where the amount is often less than 0.001 per cent.

With an alkalinity corresponding to 0.5 per cent. sodium carbonate in the mixture of milk and alcohol, a cleavage of ammonia from organic matter appeared to be brought about by this process in the case of stale, but not fresh milk.

If the boiling mixture be saturated with sodium chloride, to reduce the hydrolytic dissociation of the alkali, this cleavage is largely, if not entirely, prevented. The results thus obtained are believed to represent very closely the true amount of preformed ammonia in the samples, while the amount of 'cleavage ammonia' yielded by a sample, when submitted to this process without the addition of salt, appears to be of value as an indication of the condition of the proteid matter.

Methods in which the milk is made alkaline and boiled under atmospheric pressure to expel the ammonia, gave high results even when the dilution of the alkali was very great. Attempts to correct the amount of ammonia given off in a second period of distillation were not satisfactory.

Preliminary experiments indicate that while milk tends to develop both acidity and ammonia on standing, there is no necessary connection between the two, since either may increase rapidly while the other increases slowly, if at all.

Report of Committee on Methods for the Determination of Zinc. G. C. STONE. *Uniformity of Technical Zinc Analyses.*

Early in 1903 the committee sent out three samples of zinc ore: 'A' a pure blende from Joplin containing about 2 per cent. each of iron and lead and 0.3 per cent. of cadmium; 'B' an ore from New Jersey containing considerable amounts of manganese and iron; 'C' a Colorado blende containing about 14 per cent. of lead and 7 per cent. of copper. These were analyzed by forty-two chemists who reported from 56.97 to 59.79 zinc and 2.10 to 3.26 iron in 'A'; from 12.20 to 39.22 zinc and 18.04 to 21.92 iron in 'B'; and from 28.90 to 38.86 zinc and 8.40 to 15.00 iron in 'C.' As the results were so disgraceful the committee have classified the methods in eight groups and discussed them and the results at considerable length. They find that the discrepancies are largely due to the attempt to apply to ores to which they are totally unsuited quick methods that were devised for special cases. For the bad work the committee think the poor instruction given in many of the schools is largely to blame. The only method that gave uniformly good results is that described by Waring (*Jour. Amer. Chem. Soc.*, January, 1904, p. 9); the only reason that they do not recommend its general adoption is that it has only been tried by a very small number of analysts. In conclusion they ask for volunteers to test some of the methods more fully.

In discussing the foregoing paper Professor E. H. Miller pointed out the results obtained at Columbia University on the three samples sent out by the committee, which showed a very good agreement with the standard adopted by the committee, considering that they were done, as requested by the committee, by the method usually employed and without special precautions. Method 8, description of which appeared in the *Journal of the American Chemical Society,* for December, 1903, was discussed at considerable length by Professor Miller. The more important points brought out were: (1) That Waring's statement that the silica should be removed before the precipitation of ferric hydroxide was entirely correct, and the failure to observe this precaution might give rise to an error of 1 per cent. as shown by experiments made by Mr. Falk. (2) That Waring's method for the precipitation of zinc sulphide under pressure is excellent. (3) That the statement that zinc and cadmium can not be separated by hydrogen sulphide is absolutely wrong. The separation can be effected in a hot solution (90° C.) containing one cubic centimeter of concentrated HCl in each fifty cubic centimeters of solution, exactly the conditions given by Fresenius on page 457 of the Nacher's translation. That these conditions must be carefully maintained was shown by a series of experiments made by Mr. Falk to test the separation. (4) That a three per cent. uranium nitrate solution is preferable to uranium acetate as an indicator. (5) That the precipitation of zinc as zinc ammonium phosphate is excellent and was confirmed by the experience of fifteen years in the laboratory. (6) That the separation of zinc and manganese by oxidizing agents requires careful investigation and is not free from error as carried out at present.

The remainder of the evening was devoted to 'A Discussion of Radioactivity,' by Messrs. Wm. Hallock, Hugo Lieber, Jerome Alexander, G. B. Pegram and Charles Baskerville.

F. H. Pough,
Secretary.

DISCUSSION AND CORRESPONDENCE.

CONVOCATION WEEK.

To the Editor of Science: The writer has been interested in the series of letters in Science relating to the affairs of the American Association for the Advancement of Science, and he has an idea that the editor is encouraging these communications as a study in psychology. It is evident that the opinions and suggestions are so very diverse that no plan will be satisfactory to the whole membership. In response to the request for a contribution to the discussion the writer will briefly speak of the general outlook and policy of the association, which is the vital matter that involves all the minor questions of meetings and conduct.

During its earlier life, say from 1840 to 1880, the 'advancement' of science through popular summer meetings was doubtless a useful and successful function of the association; but now the diffusion of scientific education and the great volume of scientific literature have supplanted the association for this work of popularization. For ten years the country at large has paid practically no attention to its meetings. The large cities in which the meetings are held are equally indifferent. The leading citizens will allow their names to be used on local committee lists and will subscribe funds to bring visitors to the town, but not one in ten, probably not one in fifty, go to any session or pay the slightest attention to the meeting, although a few may join the society for a time, and thus give financial aid. The advancement of science through publicity of meetings has become an inconsequential element of the association's work. The reasons for this state of affairs are more or less obvious and are not the fault of the society.

The publication of scientific literature was never an important part of the work of the association, and it has become practically nothing, except as indirectly aided through the columns of Science.

While the sections of the society are still active it must be admitted that in the case of several sections this is only through the

cooperation or 'affiliation' of other special and independent societies.

The social function of the association is not alone sufficient to keep it effective. Comparison with the British Association is valueless, since the geographical and social conditions are entirely different.

The old days and old ways of the American Association are gone. It is natural that the older or more conservative members should feel regret over the changes and the evident trend and the loss of the pleasant summer meetings. But it is wiser to recognize the facts and adapt ourselves to the change than to shut our eyes to the handwriting on the wall. Scientific societies can not escape from the rapid and radical social evolution of the time, no matter whether we regard the changes as good or bad.

The association is still moving in a general way along old lines by virtue of its acquired momentum, but new outside forces are pushing it from its course. It is now upheld largely by the tacit cooperation of special societies and by the reverence and affection of men of science for the old, national, parent society. But knowledge is now so vast and diverse and the intellectual and economic forces so strong that specialization is inevitable, and no one society can expect to include the whole field.

The active, successful administration of the society during the last few years has greatly increased its membership, chiefly by securing the adherence of scientific men. This indicates a fundamental fact, that henceforth the association will be and ought to be conducted by and in the interests of men professionally scientific, with less deference to 'advancement,' of science by popular features. The 'American Science Association' would be a better name.

The above seem to the writer as basal facts which must be recognized in any wise planning for the future. The association may remain a great scientific and educational power if rightly conserved and directed. But, no matter what fine schemes individuals may devise, no one can clearly see the path more than one step in advance. The safest way is to trust the matter to a wise council, which should move slowly and feel the way and meet demands for change as they arise.

The association may properly become the central organization or national representative of the many special societies. If the association should be withdrawn from its present relationship to the special societies they would find it desirable to create a central body through which they might act and speak collectively. Some general organization is essential. This idea of the function of the association has already been recognized by giving the 'affiliated' societies the privilege of proportionate representation on the association council. In any scheme of consolidation the matters of association membership and finance are the most difficult to adjust, but they can be arranged satisfactorily when the necessity arrives. As sections are supplanted by special societies their ordinary scientific meetings might be suspended. However, the organization of the sections should be retained, at least for a time, for administrative purposes or other needs which may develop. The chairmanships and secretaryships of the sections would lose nothing of their honorary character because meetings for reading of papers are not held. The presidency and other general offices of the society would be even more dignified as being more broadly and powerfully representative of American science.

For some years the association and the special societies have been drawing together. The wise course is to let the evolution proceed naturally, a step at a time, as the road opens before us, and not to allow any strong personality nor any group of men to force a hasty decision on important matters. We should go slowly, but keep moving.

Here is one suggestion for immediate use. The council should be kept thoroughly representative not only of the association membership but of the affiliated societies. *A strong, wise, harmonious and not too radical council is the most important present consideration.* To this end the sections should be emphatically advised to select for officers and council representatives their most experienced and

wisest men, disregarding at this juncture mere scientific claims. The council should select for presidents at this time not representatives of science as merely to do honor but men of large experience and sympathy with the association affairs. It is of less consequence what the public thinks about the association than what we shall do for ourselves.

Realizing the gravity of the condition at this critical time the council will make wise decisions only after full discussions in a generous spirit; and the membership should in patience trust the collective wisdom of the council.

HERMAN L. FAIRCHILD.

ROCHESTER, N. Y.,
December, 1904.

'THE PROBLEMS OF EXPERIMENTAL PSYCHOLOGY.'

TO THE EDITOR OF SCIENCE: On p. 788 of your issue of December 9 (second column, line 8), I am made to speak of 'classification *a posteriori*.' What I wrote, what the sense requires, what I saw in proof, and what I left in proof, was 'classification *a potiori*.' On p. 794 (bottom of first and top of second columns), I am made to say: 'we analyze and trace to their conditions total consciousness.' What I wrote, what grammar requires, what I saw in proof, and what I left in proof, was 'consciousnesses.' A little knowledge, even in a proof-reader, is a dangerous thing.

E. B. TITCHENER.

CORNELL UNIVERSITY,
December 10, 1904.

[The errors probably would not have occurred if Professor Titchener had returned his proof to the editor in accordance with the instructions accompanying it. It was sent directly to the printers.—ED.]

SPECIAL ARTICLES.

A SUGGESTION LOOKING TOWARDS ULTRA-MICROSCOPY.

THE visibility of an object both to ordinary vision and when helped by telescope or microscope depends upon a favorable combination of several physical conditions. (1) The object must send us ethereal waves whose lengths lie between the limits of 0.38 and 0.76 microns or the violet and red ends of the spectrum respectively. (2) The difference between the intensity or color of these waves and those coming from the adjacent background must be appreciable to our nervous system. (3) The focus on the retina must be sharp. (4) The duration of the image on the retina, or, as the photographer would say, the length of the exposure, must be long enough to enable the brain to appreciate the details of the image.

By means of photography we are able to make long exposures and the fourth condition can be satisfied to such extent that fleeting pictures are caught by instantaneous exposures, while the faintest nebulæ and stars are caught by exposures that last many hours. Becquerel's first photograph by the rays that are called after his name was by an accidental exposure of many days.

By means of the schleier method, originally due to Foucault, we can overcome the difficulties of the second condition and photograph moving air waves when properly illuminated, and this method can be applied to microscopic objects and liquid substances as well as to the larger motions of the air that have been photographed by Mach, DuBois and others.

The ultimate limit of visibility is also defined by the second condition or the wave-length and intensity of the illuminating light that can affect the retina, or the sensitized photographic plate. An object that is visible by monochromatic violet light may not be visible by monochromatic red light or *vice versa*, just as a body that can vibrate to a given high pitch is often too small to send out a low note. An ear that is too dull to hear the low notes may hear a high pitch. Our retina is so constructed as to be insensible to ultra-violet light, but we can by fluorescence make short waves become visible, *i. e.*, an object illuminated by ultra-violet light whose wave-lengths may be anywhere from zero to 0.38 microns may be too small to be directly affected by long waves, but will, by fluorescence convert the short waves into longer ones whose lengths may be any given multiple of the ultra-violet wave, and will,

therefore, be visible to us if the length of the multiple lies between 0.38 and 0.76.

If, therefore, for botanical, physiological and bacteriological work we stain our preparations with fluorescent substances and illuminate with ultra-violet light, we shall bring into prominence smaller particles or structures than can possibly be seen with the ordinary white or colored light. Or, if we prefer, instead of the retina we may expose a sensitized plate, especially one that is sensitive to the particular fluorescent waves excited by the special ultra-violet light that we employ.

But the success of this modification of the ordinary methods depends also upon having our microscope lenses so ground as to correct for the particular waves that we are employing. In fact, one may conceive that an ultra-violet wave of, for example, 0.09 microns may by fluorescence excite a wave of 0.18, or 0.27, or 0.36 microns, and will, therefore, still be invisible to the eye, while perfectly competent to do photographic work. It will, therefore, be a great labor to grind the lenses properly, since their perfection can only be tested by experiments with invisible fluorescent rays; but when perfected these lenses and the photographs give us a power of what we may at present call 'ultra-microscope research.' The development of such work is limited only by the chemical and physical properties of atoms and molecules, and is not in any way affected by the limitations of the human eye.

The first steps toward realizing this advance in microscopy will naturally be made with the ordinary microscope, and the ordinary soluble fluorescent substances, among which we recall eosine, thallene, quinine, æsculine, chlorophyll, magdala red. If now with the fluorescent staining and ultra-violet illumination we combine the principles of the schleier method it would seem that there will in the future be no limit to the powers of research, except that which is set by the diffraction phenomena. The ultimate limit of actual photographic visibility will be of the dimension of one or two of the very shortest wave-lengths of ether, or of the same dimensions as the larger molecules themselves.

It is possible that Professor Ernst Abbe, of Jena, and his colleagues have been working along some line of thought similar to the preceding, as I notice that in the list of scientific instruments in the German educational exhibit at the St. Louis Exposition, page 213, mention is made of the ultra-microscopic work, but from what little is stated it would seem possible that this refers especially to the ordinary microscope combined with the schleier method; I have not as yet learned of any details and may be entirely wrong. The flood of ultra-violet light given out by the soft-iron electrodes of Dr. Piffard's tube and the magnificent fluorescent effects displayed by Mr. Geo. F. Kunz in his lectures suggested to me the preceding combination of fluorescence, the schleier method, and the microphotograph, and I have been encouraged to publish the idea.

To-day an interview with Dr. Sigfried Czapsky, a colleague of Professor Abbe's, has brought to my attention the fact that great improvements in ultra-microscope work are in progress at Jena, but not yet sufficiently developed to justify publication. I have, therefore, taken the liberty of sending you this communication in hopes that there will be some suggestion in it worthy the attention of these eminent opticians.

CLEVELAND ABBE.

WASHINGTON,
November 6, 1904.

EXTINCT PEDICULATE AND OTHER FISHES.

WHILE engaged on chapters relative to the Pediculates for a work on fishes, I was extremely pleased to receive just what I wanted —further information respecting the former history of the order. I had received from Dr. C. R. Eastman an interesting 'Bulletin of the Museum of Comparative Zoology' entitled 'Descriptions of Bolca Fishes.' In that were figures and description of a form referred to '*Lophiidæ*' and named *Histionotophorus bassani* (Zigno). A close examination of the reproductions of photographic figures, however, convinced me that the fish was not one of the lophiids but a typical antennariid. The mode of fossilization showed that it was a com-

pressed fish and the structure and relations of the fins to each other and the interspinals, as well as other skeletal details, conclusively demonstrated that the animal was closely related to the existing *Antennarius* and *Pterophryne*. Indeed, with skeletons of those forms before me, after elimination of faults of restoration, I could find no generic differences between the fossil and the recent *Pterophryne*. The caudal of the extinct species, it is true, was longer and that difference may be correlated with others observable by close scrutiny, but the figures published do not give details with sufficient clearness to appreciate them.

Still more apt than Dr. Eastman supposed, then, are his remarks: "Attention should be called * * * to the remarkable fact of a type of fish-life appearing suddenly in the Eocene, already highly modified, without any known predecessors nor any that can be plausibly conjectured, but which persists after its first introduction essentially unchanged until modern times."

The recognition of the relationship of '*Histionotophorus*' accentuates the deduction. We now have two (the only known) eocene Pediculates so nearly related to greatly differentiated recent forms that their generic differences, if any, remain to be discovered—the *Lophius brachysomus* and *Histionotophorus* (perhaps *Pterophryne*) *bassani*. Yet the Pediculates are exceptionally aberrant and specialized fishes. The significance of the facts may be appreciated when it is recalled that nearly all the contemporary mammals belonged to extinct families or, conversely, that almost all the recent families have been evolved since—so far as we know.

The history of the form is noteworthy. De Zigno (1887) recognized its similarity to the genus *Antennarius* (Questa forma * * * presenta qualche somiglianza col genere *Antennarius* di *Commerson*) but distinguished it by its form, horizontal mouth and elongated fin-rays, especially those of the caudal. Smith Woodward, without reference to the views of De Zigno, noticed it, among the 'Scorpænidæ,' as one of the 'extinct genera and species, which are not represented in the collection, [and] are supposed to be related to *Scorpæna*.' Eastman's view has just been given. It only remains to add that no such differences as are urged by De Zigno exist, except the long caudal rays. The horizontal mouth is the result of distortion through pressure. The figures marked on Eastman's plate (I.) '1.' and '1a' show the subvertical mouth.

One more of several points raised by Dr. Eastman's important memoir may be alluded to.

Another Monte Bolca fish has been described and photographed as *Symphodus szajnochæ* (= *Crenilabrus szajnochæ* Zigno). The non-labrine appearance and osteological characters led me to read the description. It appears, according to Dr. Eastman, that 'there are at least eight branchiostegal rays' and that 'the scales are thin, ctenoidal and very strongly pectinated.' It is, therefore, evident that the species is not even related to the labrids. The characters specified are rather those of berycids, but it belongs to no known genus and the family even is uncertain. The combination of form, rounded caudal, single dorsal with eleven stout spines, and anal opposite soft dorsal, with ctenoid scales and increased branchiostegal rays, separate it from any other fish, so far as known, and it may be differentiated as a distinct generic type and named *Bradyurus*. It is to be hoped that Dr. Eastman may reexamine the fish and give the results of his review.

Theo. Gill.

THE RE-DISCOVERY OF DINOMYS.

The great rat-like rodent *Dinomys* was discovered in 1873 in the Peruvian Andes, and since that time the specimen, which is preserved in the Berlin Museum, has remained unique. In the spring of this year Dr. Goeldi, of the Museum of Para, announced the rediscovery of this rare animal in the lowlands of Brazil. The following notes as to its appearance and habits are abridged from Dr. Goeldi's account of this animal which appeared in the *Proceedings of the Zoological Society* for May and June.

The general build of *Dinomys* is thick-set and inclined to corpulency. Due to the fact of setting

the whole plantigrade sole on the ground, the hind feet especially, the *Dinomys* has a waddling gait, and reminds one of an immense rat well advanced in development towards a bear.

The predominant feature of the character of *Dinomys* is a combination of leisurely movements and supreme good nature. It knows absolutely nothing of haste. Spending the greater part of the day sleeping in a corner—the mother often lying upon the young one, or standing over it, as if to protect and to keep it warm—opening its half-closed eyes only when it hears the approaching steps of the keeper, it forms the resolution to move with slow gait, expecting some food, evidently governing its movements as much by hearing and smell as by sight. It is not easily irritated, and permits one to stroke and to scratch its head and back, and only occasionally manifests its displeasure by a low guttural growl. I have never yet observed a manifest intention to bite. When let out of the cage it makes no attempt to escape, and limits its excursions to an exploration of the immediate neighborhood in search of something to eat. It occasionally scratches itself rapidly with its long claws, which is the only occasion on which it manifests a capacity for rapid movements when required. One thing not yet definitely verified by us is its proclivity for digging, the development of the claws at least leading to the supposition that the animal is well fitted for that purpose. The amiable relations always existing between mother and son prepossesses one most favorably as to the natural disposition of the animals.

As matters now stand, it would be justifiable to suppose that the true home of *Dinomys* is not properly in the Peruvian Andes, and that the first specimen found there was merely a stray individual and that its actual habitat may rather be located in the almost unexplored regions of the eastern slopes and tablelands of the Bolivian and Peruvian foot-hills bordering on Brazil, including geographically the head-waters of the rivers Acre, Purûs and Juruá. F. A. LUCAS.

CURRENT NOTES ON METEOROLOGY.

MONTHLY WEATHER REVIEW.

THE two latest issues of the *Monthly Weather Review* (July and August, 1904, dated September 19 and October 21 respectively) contain the following papers of general interest: 'The Movements of the High Clouds in the West Indies,' by J. T. Quinn; 'Attempts at Methodical Forecasting of the Weather,' by L. Besson (translated from the French); 'Air Radiation,' by C. C. Hutchins and J. C. Pearson, of Bowdoin College; and notes on 'Meteorology at Montpellier, France,' 'Early American Weather Records,' 'Weather and Crops in Arizona,' 'The Climate of Manila,' 'Secular Changes in Climate,' 'The Capacity of the Air for Aqueous Vapor,' 'Temperature of the Upper Atmosphere,' 'Precipitation in Wisconsin,' 'Meteorology in Chile' and 'Cannonading against Hail.' Further, 'The Annual and Geographical Distribution of Cyclones of High Velocity in the United States, 1893–1902,' by Stanislav Hanzlik; 'Dust in the Atmosphere during 1902–03,' by Andrew Noble; 'The Origin of the Cuba Cyclones of June 13–14, 1904,' by Maxwell Hall; and the following notes: 'The Primary and Secondary Rainbows,' 'Formation and Movement of Hurricanes,' 'A Legal Decision as to Damage by Lightning and Wind,' 'Are the Movements of Thunderstorms deflected by the Tide?' and 'The Diurnal Variation of the Barometer at Milwaukee.'

CHANGES IN BLOOD AT HIGH ALTITUDES.

DR. K. BURKER, of the Physiological Institute of Tübingen, has been making an experimental study of the physiological effects of high altitudes at the Schatzalp Sanatorium, 6,119 feet above sea-level. In the case of rabbits brought from a lower level, and kept for different lengths of time at 6,000 feet, an increase of 25 per cent. in the amount of iron in the blood was noted. The liver showed first an increase of iron; then, after a longer time at the greater altitude, a decrease, and in the case of rabbits kept still longer, there appeared to be less iron than in the livers of rabbits at Tübingen. In a similar line are the studies of the blood of human beings made by Dr. Gaule during two balloon trips. The effect of the balloon trips was to increase the number of red corpuscles of each of the persons examined. Similar results have previously been obtained by Viault, Müntz and others.

AN INSTRUMENT FOR DETERMINING WIND AT SEA.

IN the *Quarterly Journal of the Royal*

Meteorological Society, October, 1904, Mr. A. L. Rotch, of Blue Hill Observatory, describes an instrument for determining the true direction and velocity of the wind at sea, devised by himself and constructed by Casella, of London. With this instrument the angles of the apparent and true wind relative to the ship are measured directly, and by utilizing the ship's course and speed as a base, absolute directions and velocities of both winds are immediately ascertained.

GENERAL CIRCULATION OF THE ATMOSPHERE.

THE report by Hildebrandsson, to the International Meteorological Committee, on the international cloud observations, the principal conclusions in which were some months ago referred to in these 'Notes,' is published in English in the *Quarterly Journal of the Royal Meteorological Society,* Vol. XXX., October, 1904. This study has attracted much attention because of the new views advanced in it concerning the general circulation of the atmosphere, and it is well to have it accessible to a larger number of readers than was the case with the original publication in French.

KITE-FLYING AT SEA.

DURING the past summer, the Prince of Monaco has been investigating the meteorology of the free air in the northeast trade wind latitudes. Kites have been flown from the yacht *Princess Alice,* and an altitude of nearly 17,000 feet was attained on one occasion. In this kite work, Dr. Hergesell was actively interested and he accompanied the expedition, but Americans will recall that the first suggestion concerning the use of kites for exploring the atmosphere over the oceans was made by Mr. A. L. Rotch, of Blue Hill Observatory.

METEOROLOGICAL INSTITUTE OF SAXONY.

THE 'Jahrbuch' of the Royal Meteorological Institute of Saxony for 1900, compiled by Dr. Paul Schreiber, contains an elaborate critical discussion of the pressure observations made in Saxony between 1866 and 1900, as well as the meteorological summary for the year 1900, with special discussions of evaporation measurements, thunderstorms and depth of snowfall. R. DEC. WARD.

BOTANICAL NOTES.

STUDIES IN PLANT FECUNDATION.

A VERY useful compilation representing the present state of our knowledge of the process of fecundation in plants has recently appeared from the hand of Professor D. H. Mottier in one of the publications (No. 15) of the Carnegie Institution of Washington, under the title of 'Fecundation in Plants.' It is a thick octavo pamphlet of nearly two hundred pages, with seventy-five text illustrations. The author's purpose is well stated in the preface to be 'to present the subject of fecundation in the vegetable kingdom by the discussion of concrete cases, selecting from the great groups of plants certain typical representatives in which the sexual process seems to have been most thoroughly investigated.' In carrying out this purpose he devotes an introductory chapter of sixty pages to the discussion of typical problems of nuclear division and cell formation, especially in spore mother-cells, closing the chapter with an interesting ten-page discussion of the significance of the sexual process. In the latter the author is very emphatic in his disbelief in a chemical theory of fecundation. "Although the development of a rudimentary embryo induced by artificial means may proceed in the same manner as the product of normal fecundation, yet the artificial stimulus can not be looked upon as being equivalent to the sexual process. In the case of the former, we are dealing with a stimulus which merely starts growth, but a mature individual is never developed. The sting of an insect or some similar stimulus may call forth a growth in a leaf of an oak which results in a gall, a local and limited growth, but never in an oak tree, and we can not for one moment think of comparing such a stimulus to a sexual process." And again, 'The author does not agree with those who regard the sexual process merely as a restoration to the egg of the power of growth and division.'

The second chapter includes the discussion of typical cases of fecundation in which motile isogametes are concerned, the examples selected being *Ulothrix, Hydrodictyon* and *Ectocarpus.* Here he shows 'that fecundation

consists in the fusion of the sexual nuclei together with the cytoplasm of the gametes.' In Chapter III. fecundation by non-motile isogametes is considered, as illustrated by *Sporodinia, Closterium, Cosmarium,* the Diatoms (*Rhopalodia, Cocconeis*) and *Basidiobolus.* In Chapter IV. the heterogamic fecundation of *Sphæroplea,* the Fucaceæ, *Volvox, Œdogonium, Coleochæte, Vaucheria, Albugo, Achlya* and *Saprolegnia* are discussed. Then follow chapters on 'the type of the *Ascomycetes* and Rhodophyceæ (V.), 'the Archegoniates' (VI.), including Pteridophyta and Gymnosperms, and 'Angiosperms' (VII.). In this last chapter the author says, 'the view held here is that pollen grains and embryo-sacs are respectively micro- and macrospores.' Here the author has permitted some confusion to creep into his usually lucid text, for a little later he uses the expression 'the embryo-sac or female gametophyte' (pp. 169 and 173). Certainly an embryo-sac can not be both macrospore and female gametophyte. A voluminous bibliography, including 187 titles, closes the paper, which can not but prove to be very useful to botanical teachers and students.

TECHNICAL MYCOLOGY.

SEVEN years ago Doctor Franz Lafar, private docent in the technical high school at Hohenheim, issued the first part of a most useful work under the title 'Technische Mykologie.' About a year ago the second part appeared, and with it the announcement that the present edition was to be discontinued, and that a second, much enlarged edition was to be undertaken immediately. Of this new edition the first *Lieferung* of 160 pages has just appeared. It includes an introduction of 28 pages—mostly historical—by Dr. Lafar, followed by 121 pages by Dr. Migula devoted to the bacteria. Near the close of the *Lieferung* we have the beginning of Dr. Lindau's treatment of the true-fungi (*Eumycetes*). If one may judge from these pages, this edition is to be a notable addition to mycological literature. From the prospectus it is learned there are to be five volumes, the first of which is to be devoted to the general morphology and physiology of the fungi. The succeeding volumes are to be more or less technical, dealing with the relation of the fungi to various industries, the soil, water-supply, etc.

PARTHENOGENESIS IN PLANTS.

IN a recent number of the *Berichte der deutschen Botanische Gesellschaft* (Vol. XXII.), Dr. J. B. Overton describes the cytology of parthenogenesis in *Thalictrum purpurascens,* a common American weed. The author has prepared a summary of this paper, as follows:

In a previous experimental and morphological study the author discovered that this plant sets seed freely in the absence of pollination and that the embryos could develop normally from fertilized egg-cells and also parthenogenetically from unfertilized egg-cells. In the present investigation the author studied the cytological phases of the subject. He was able to determine that the number of chromosomes was reduced by one half in the pollen-mother-cells by means of the heterotypical mitosis. Similar conditions were also found in the typical embryo-sac mother-cell, which gives rise to true tetrads. He also found in exceptional cases embryo-sac mother-cells in which no reduction takes place. The division, instead of being heterotypical, appears to resemble both vegetative and heterotypical mitoses. This division, therefore, represents a transitional stage between the ordinary somatic and the heterotypical divisions. Instead of twelve chromosomes, the reduced number, the spindle shows twenty-four chromosomes. In those embryos which developed from normally fertilized eggs as well as those which developed parthenogenetically, he found twenty-four chromosomes. Twenty-four chromosomes were always found in purely vegetable cells. The author concludes that only those eggs with the somatic number of chromosomes are able to develop parthenogenetically, while those which contain the reduced number of chromosomes must be fertilized. The works of Juel and Murbeck show that *Antennaria alpina,* several species of *Alchemilla* and *Taraxacum officinale,* have acquired the habit of complete parthenogenesis. *Thalictrum purpurascens* has only partly attained the power of propagating itself parthenogenetically. The author believes it possible that the failure of pollination, due to a separation of staminate and pistillate plants, has acted as a stimulus to final parthenogenetic development.

THE WESTERN SAND CHERRY.

Most eastern readers are well acquainted with the low, much-branched shrub known as the sand cherry (*Prunus pumila*), and bearing small fruits which have a thin flesh. Probably few of them are familiar with the western sand cherry (*Prunus besseyi*) which grows on the prairies and great plains from Manitoba and Minnesota to Nebraska and Kansas. The latter has a much larger, short-stalked cherry, which has a colored, juicy flesh. The plants of the two species are much alike, but there are constant differences in habit and fruit sufficient to warrant their separation. For practical purposes the two are very distinct, the western species, even in the wild state, being valuable for culinary purposes.

In a recent bulletin (No. 87) of the North Dakota Experiment Station, Professor Hanson makes a discussion of this fruit, giving the results of his experiments extending over fourteen or fifteen years. These may be summarized as follows:

1. It is exceedingly variable in the size and quality of its fruit, but all forms are acceptable for culinary use.

2. From them 100 varieties have been selected, and are now under propagation. Some of these bear fruit from three fourths to seven eighths inches in diameter and of a quality acceptable for eating without cooking.

3. It hybridizes readily with at least three other species.

4. Seedlings bear fruit in the third year.

5. "After fruiting many thousands of seedlings it appears reasonable to believe that in this species we have a bush cherry that can be raised to advantage upon the most exposed prairies."

As to the present value of this species, Professor Hansen says:

1. "It is a native northwestern prairie fruit worthy of being tamed and transferred to the small fruit garden."

2. "It is yet in the early stages of development; too much must not be expected at first."

3. "Even unselected seedlings are not to be despised in the drier regions of the northwest, where the small fruits of the eastern states are usually a failure."

4. "At least one of its hybrids (the 'Compass,' = Sand Cherry × Miner Plum) is worthy of a place in the home garden, and may be considered the forerunner of a new race of fruits."

5. "Propagators will find the sand cherry worthy of attention as a stock in winter root-grafting of the native plum."

6. "For orchard houses and amateur plantations it can be used to advantage, as a dwarf stock for plums, peaches, apricots and some other stone fruits."

7. "It is worthy of a place on the list of desirable low ornamental shrubs for the foreground in clumps of larger-growing species."

The professor's experience with the sand cherry has been so favorable that he ventures the following predictions:

1. "It will be found of great value in the commercial propagation of some of the stone fruits."

2. "From it will be developed by selection a race of bush fruits with fruits equal to California cherries in size, and of quality acceptable for table use."

3. "From it will be developed a race of hybrid fruits of a new type by hybridizing with choicer fruits: these new creations will be hardy and fruitful on the most exposed prairies."

Charles E. Bessey.
The University of Nebraska.

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*COLLEGE-ENTRANCE OPTION IN ZOOLOGY.**

The following report will be presented to the American Society of Zoologists at the meeting at Philadelphia in December. It is published here in order to call forth criticisms and suggestions from schools and colleges which have not been reached through correspondence. Communications relating to the report may be handed to any member of the undersigned committee, or addressed to the chairman at Teachers College, Columbia University.

Believing that zoology should have a place in general liberal education and recognizing that for the great majority of citizens formal

* Report of a committee appointed by the American Society of Zoologists.

education must end with the secondary school, it is the opinion of this committee (1) that this science should be taught in high schools for the benefit of pupils who will have no other opportunity of acquiring general knowledge of animals; and (2) that zoology thus taught from the point of view of general secondary education should have recognition as a college-entrance option, in order that pupils who can not decide to go to college before the close of high-school work may not be held deficient in credits because zoology was elected. But, although thus recognizing zoology from the standpoint of secondary education, this committee wishes to emphasize the opinion that zoology is not one of the most desirable subjects as preparation for college; and that the physical sciences should first of all be recommended to pupils who expect to go to college.

In reaching these conclusions the committee has not failed to consider the value of general acquaintance with common animals and with the essential principles of the elementary physiology and hygiene of the human body, but these are commonly taught in the years below the second of high school, and work in these lower years does not in the case of other subjects closely concern the question of college-entrance options.

These preliminary statements will make it clear that the following suggestions for a scheme of college-entrance credits in zoology are intended by this committee simply to provide for crediting the zoology which should be elective in every good general high school, but not to advocate the subject as one which from the college standpoint is desirable in preparation for college. In other words, this committee is simply recommending that zoology studied as part of a liberal secondary education intended primarily to prepare for life should be recognized as preparing for entrance to college (the minor question of preparation for entrance to college courses in zoology being here laid aside).

General Statement of Options.—(*a*) One-point option. To count as one unit or point in thirteen to fifteen required for entrance to college. This should consist of one year of at least five hours per week devoted to study of zoology, as indicated in outline of course given below.

(*b*) Half-point option (one point in biology). To count as one half unit in thirteen to fifteen required, only when a half unit of botany taken in the same continuous course is offered to complete a full unit in biological science. A half year of zoology independent of botany should not be accepted.

A two-point option is not recommended, because more than one full year in zoology is extreme specialization which no secondary school can properly undertake.

Outline for the One-Point Option in Zoology.—The following outline includes the principles of zoology which are indispensable to a general survey of the science. It is not intended to indicate order of study of the topics—this must be left to the teacher and the text-book. With little modification the courses presented in general books such as Needham's, Kingsley's, Kellogg's and Colton's (revised) cover the ground outlined below.

1. The general natural history—including general external structure in relation to adaptations, life histories, geographical range, relations to other plants and animals, and economic relations—of at least one animal of each prominent order of vertebrates and one of each prominent class of invertebrates so far as representatives of these groups are obtainable in the locality where the course is given. In the case of arthropods, pupils should become familiar with common crustaceans, spiders, myriapods, and insects representing at least five orders. Actual examination of common animals with reference to the above points should be supplemented by reading giving natural-history information equivalent to that in recent books by Davenport, Jordan & Heath, or Kingsley.*

2. The classification of animals into phyla and leading classes (except the modern subdivisions of the worms) and the great characteristics of these groups. In the case of in-

* A large part of this natural-history information will be gained from the nature-study of the elementary school and from [illegible] given in the first year of high

sects and vertebrates the characteristics of the prominent orders. The teaching of classification should be by practical work so as to train the pupil to recognize animals and to point out the chief taxonomic characteristics. The meaning of species, genera and larger groups should be developed by constructive practical work with representatives of insect or vertebrate orders.

3. The general plan of internal structure, not the anatomical minutiæ, of one vertebrate (preferably frog or fish) in general comparison with human body; an arthropod (preferably a decapod); an annelid (earthworm or Nereis); a cœlenterate (hydroid, hydra or sea-anemone); a protozoon (a ciliate, and amœba when possible). In place of any of above types not locally available there may be substituted a second vertebrate, an insect or an echinoderm. Tissues should be examined first with the unaided eye, in such a structure as a frog's leg, and then with a microscope demonstrate the relations of cells and intercellular substance in epithelium and cartilage; and, if possible, in other tissues. The functions of the chief tissues and their positions in the body of a vertebrate should be pointed out.

4. (*a*) The general physiology of above types, involving the essentials of digestion, absorption, circulation (respiration), cell-metabolism, secretion, excretion and nervous functions. This should apply comparatively the essentials of elementary work in human physiology (see chapters 8, 9 and 10 in Martin's 'Human Body, Briefer Course'). Demonstrations and experiments, such as are suggested in high-school text-books on human physiology, should be introduced, or recalled if not previously well presented in elementary physiology, in connection with the discussion of the chief functions. As far as practicable structure and function should be studied together.

(*b*) Comparison of the general life-processes in animals and plants (in connection with botany if zoology is first studied).

5. The very general features of asexual reproduction of a protozoon (preferably *Paramœcium*); alternation of generations in hydroids; reproduction and regeneration of *Hydra;* the very general external features of embryological development in a fish or frog; and the general cellular nature (not centrosomes and the like) of germ-cells, fertilization and cell division in developing eggs should, as far as possible, be demonstrated and briefly described. Also, the most interesting features of development should be pointed out in the case of other animals studied. (The limited microscopic work suggested above might all be carried out with only one microscope for demonstrations.)

6. The prominent evidences of relationship, suggesting evolution, within such groups as the decapods, the insects and the vertebrates, should be demonstrated. A few facts indicating the struggle for existence, adaptation to environment, variations of individuals and man's selective influence should be pointed out; but the factors of evolution and the discussion of its theories should not be attempted.

7. Some leading facts regarding the epoch-making discoveries of biological history and the careers of such eminent naturalists as Darwin, Huxley, Pasteur and Agassiz should be presented.

The above outline of a course in general zoology should be developed on the basis of a course of laboratory study guided by definite directions. This should be supplemented by the careful reading of at least one modern elementary text-book in general zoology. At least two thirds of the time should be devoted to the practical studies of the laboratory. If good nature-studies have not preceded the course in high-school zoology, pupils should be encouraged to do supplementary work in the line of natural history. A note-book with carefully labeled outline drawings of the chief structures studied, and with notes on demonstrations and in explanation of drawings, with dates and an index, must be submitted, properly certified by the teacher, at the time of the examination. It will be graded as one third of the examination.

The question whether a course as outlined above should admit students to the second college course in zoology is one which must be answered by each college for itself. It is

quite unimportant so far as accepting an entrance option in zoology is concerned, for the very few pupils who study the science in high school and later in college have special interests which make adjustment of their college work easy.

Outline for the Half-Point Option.—(1) The general natural history specified above. (2) The classification of animals specified above. (3) The general internal structure of one vertebrate and a decapod or annelid. (4) The physiology of these two animals along the lines suggested above, with special application to the functions of the human body, and comparison with the general functions of plants. (5) The general external embryology of frog as suggested above.

Committee: C. M. CLAPP,
E. G. CONKLIN,
C. W. HARGITT,
J. S. KINGSLEY,
M. A. BIGELOW, *Chairman.*

THE JOHN BELL SCOTT MEMORIAL OF WESLEYAN UNIVERSITY.

THE John Bell Scott Memorial, the physical laboratory of Wesleyan University, was dedicated on December 7. The building was presented on behalf of the building committee by Dr. H. C. M. Ingraham and a response was made by President Raymond. The principal address was made by Dr. Edward B. Rosa, formerly professor of physics at Wesleyan University and now physicist of the National Bureau of Standards. The address, which will be published in SCIENCE, was on 'The National Bureau of Standards in Relation to Scientific and Technical Laboratories.'

The John Bell Scott Memorial is a gift to Wesleyan University from the late Charles Scott, of Philadelphia, and his son Charles Scott, who died from disease contracted while serving as chaplain of the U. S. Cruiser *St. Paul,* during the Spanish-American War. The building is a handsome structure of Harvard brick and Indiana limestone, the architect being Mr. Charles A. Rich, of New York City, well known in college circles for his exceptional success as the architect of the splendid new group of college buildings at Dartmouth. The main part of the building is 102 x 51 feet on the ground plan, and this part consists of basement, three stories and attic. In addition there is an extension of 50 x 30 feet in the rear which has basement and two stories. The lecture room is situated on the second floor, running out into the extension, is 44 x 40 x 17 feet in size and seats nearly 200 persons. A smaller lecture room on the third floor has a seating capacity of about forty. There are in the building twenty-two rooms which are more distinctively for laboratory purposes, in addition to the lecture rooms, offices, photographic dark rooms, store rooms, apparatus rooms, etc. For experiments which require great vertical space, a tower has been provided about 4 x 6 feet in cross section and with a height of about 54 feet in the clear. The building is abundantly supplied with water and gas connections throughout and is exceptionally well equipped with a system of wiring for distributing to all points alternating and direct current from the city mains and also direct current from the storage battery room in the basement.

THE GERMAN METEOROLOGICAL AND MAGNETIC OBSERVATORY IN THE SAMOAN ISLANDS.

DR. FRANZ LINCKE, of Göttingen, Germany, has been appointed to take charge of the German Meteorological and Magnetic Observatory at Apia, Samoan Islands, thus relieving Dr. Tetens, who returns to Germany in order to reduce the records obtained during the past two years. This observatory is equipped with the most modern instruments for observations in meteorology, terrestrial magnetism, atmospheric electricity and seismology. In view of the important location of this station and the opportunity presented to supplement the data obtained at the Coast and Geodetic Survey Magnetic Observatory in the Hawaiian Islands, situated on the opposite side of the magnetic equator from that of the Samoan station, the German government has decided to further continue its observatory. It was the original intention to conduct the work only during the time of the German and British Antarctic expeditions.

En route to Samoa, Dr. Lincke stopped at Washington, November 17–21, and compared a set of portable magnetic instruments with the Coast and Geodetic Survey standards at Cheltenham, Maryland, he having previously compared the same set with the Potsdam magnetic observatory standards. Upon his arrival at Apia, he will compare this set with the observatory instruments used there and thus secure the necessary data for correlating the various observatory standards. Arrangements are thus being perfected for effective cooperation between the magnetic observatories of the German government and those of this country.

A MONUMENT TO J. W. POWELL.

During the recent excursion of the Eighth International Geographic Congress to the Grand Canyon of the Colorado in Arizona, a meeting was held in memory of Major J. W. Powell, in which his exploration of the canyon, his western surveys and his work as director of the United States Geological Survey and as organizer of the Bureau of Ethnology were briefly described. At the close of the meeting the following vote was passed:—

The members of the Eighth International Geographic Congress who visited the Grand Canyon of the Colorado River on September 26 and 27, 1904, express the hope that a suitable monument may be erected on the edge of the plateau overlooking the Grand Canyon to commemorate the labors of John Wesley Powell as explorer, geologist and ethnologist; and they request that committee, consisting of Messrs. Davis (temporary chairman), Bryant, Day, Gilbert, Hill, Libbey, McGee, Salisbury and Walcott, with power to add to their number, take steps to carry the above suggestion into effect.

The record of the vote was signed by fifty-four members of the congress excursion. A meeting of the committee will be held in Philadelphia, on Friday, December 30, for the purpose of organizing and taking such action as may seem appropriate.

SCIENTIFIC NOTES AND NEWS.

Dr. R. S. Woodward, professor of mechanics and mathematical physics and dean of the faculty of pure science, Columbia University, was elected president of the Carnegie Institution at the meeting of the trustees held at Washington, on December 13.

At the meeting of the trustees of Princeton University on December 8 the resignation of Professor Charles A. Young from the chair of astronomy was accepted to take effect at the close of the present academic year, when he will become professor emeritus. Professor Young has held the chair of astronomy at Princeton since 1877. He celebrated his seventieth birthday on December 15.

The council of the Edinburgh Royal Society at its recent meeting, decided to award to Professor Sir J. Dewar, F.R.S., the Gunning Victoria jubilee prize for 1900–1904, for his researches on the liquefaction of gases extending over the last quarter of a century, and on the chemical and physical properties of substances at low temperatures.

M. Dastre, professor of medicine at Paris, has been elected a member of the Paris Academy of Sciences.

Dr. J. Mackintosh Bell, instructor in geology at Harvard University, a nephew of Dr. Robert Bell, F.R.S., acting director of the Geological Survey of Canada, has been appointed government geologist of New Zealand to succeed Sir James Hector.

The next autumn meeting of the Iron and Steel Institute of Great Britain will be held at Sheffield under the presidency of Mr. R. A. Hadfield.

Dr. Victor C. Vaughan, of the University of Michigan, addressed the Philadelphia Pathological Society on December 8, at the College of Physicians, on the 'Relation of Food Adulteration to the Public Health.' A reception was tendered to Dr. Vaughan after the meeting.

Dr. E. O. Hovey, of the American Museum of Natural History, lectured at the Massachusetts Institute of Technology on December 8, under the auspices of the Society of Arts, on 'Mont Pelé: the Eruptions of 1902 and the Growth and Destruction of the Great Spine, or Obelisk.'

DR. SVEN HEDIN, the Swedish explorer, is now in St. Petersburg, and will shortly deliver a lecture on the scientific results of his travels in Central Asia.

MR. ALEXANDER SIEMENS gave his inaugural address before the British Institution of Electrical Engineers on December 10.

THE Massachusetts Institute of Technology celebrated on December 7 the one hundredth anniversary of the birth of its founder and first president, William Barton Rogers.

A SUBSCRIPTION, headed by M. Albert Gaudry, has been started for a monument to M. Bernard Renault, well known for his valuable researches into the microorganisms of the coal measures, and especially of the bogheads and of the cannel coal of the United States, who died from overwork and in limited circumstances on October 14 last. The monument will be erected at his native place, Autun, where he is buried, and subscriptions should be sent to M. Berthier, secretaire de la Société d'histoire naturelle, 2, rue de l'Arbalète, Autun, France.

DR. GEORGE VIVIAN POORE, formerly professor of medicine in University College, London, died on November 23.

A DONOR, who desires to remain anonymous, has placed £1,000 in the hands of the treasurer of the Royal Society, £500 to be placed to the credit of the 'Catalogue of Scientific Papers Account' of the Royal Society, and the remainder to the credit of the 'National Physical Laboratory Account.'

THE Physico-Chemical Club of Boston and Cambridge has begun the third year of its membership with over sixty members. At the first meeting of the year, in November, Professor T. W. Richards, of Harvard, was elected president, in place of Professor A. A. Noyes, of the Massachusetts Institute of Technology, who has held the post for two years. Professor Noyes was made vice-president, and his colleague, Professor W. D. Coolidge, was made secretary and treasurer. Dr. G. P. Baxter described his important work on the atomic weights of iodine, and Mr. E. C. Kraus spoke of his interesting work on the remarkable properties of solutions in liquid ammonia.

THE trustees of the Wagner Free Institute of Science of Philadelphia announce that in view of the largely increased facilities provided within the past few years by the publication departments of the various institutions of learning, and more especially by the Carnegie Institution, for the promotion of original research with its incident publications, the Wagner Free Institute of Science has thought it wise to discontinue for the present its work in this department and to devote its energies more exclusively to other purposes indicated by its founder.

THE twenty-fifth annual report of the director of the United States Geological Survey is now ready. It contains 388 pages and is illustrated with 25 maps, which show the progress of topographic or geologic surveys made in different parts of the United States and Alaska. The general results achieved by the survey in the twenty-five years of its existence are summarized, and a *résumé* is given of the work accomplished by each of the survey's great divisions during the fiscal year from July, 1903, to July, 1904.

A PUBLIC museum has been incorporated at St. Louis. It is proposed to secure some of the objects exhibited at the St. Louis Exposition.

LADY FLOWER writes to the London *Times* that Mr. G. W. Duff-Assheton-Smith, whose death was recently recorded in *The Times*, stocked his park at Vaynol with many rare and interesting animals, including the large moose and small Japanese deer, old English white cattle, American bison, zebras, kangaroos and emus. One of the otters was so tame that when swimming in the lake it would come back when whistled to. Mr. Assheton-Smith was a courteous and kindly country gentleman, and his knowledge of animals and bird life was remarkable.

THE Bureau of Forestry has recently signed an agreement to make extensive timber seasoning tests in two western states, in cooperation with two telegraph and telephone companies. Experimental stations will be located

at Martinette, Wis., and Escanaba, Mich.; and probably a third station will be established at Ashland, Wis. The expense of the experiments will be borne jointly by the bureau and the companies. Cedar and tamarack telephone and telegraph poles will be furnished by the state of Wisconsin free of cost, and two railroad companies have agreed to haul them to the experiment stations without charge for freight.

UNIVERSITY AND EDUCATIONAL NEWS.

A GIFT of $50,000 by Mr. Edward D. Adams, in memory of his son, Ernest K. Adams, has been made to Columbia University for the foundation of a research fellowship in physical science. The gift is accompanied by a valuable collection of scientific apparatus to be allotted to the electrical, physical and psychological laboratories of the university.

IT was made a condition of granting a charter to the University of Leeds that an endowment fund of at least £100,000 should be collected. Of this sum over $60,000 has been subscribed.

THE Liverpool city council has voted the sum of £10,000 towards the support of the University of Liverpool.

BY the will of Mr. G. T. B. Wigan, M.A., of Trinity College, Cambridge, a sum of above £9,000 was bequeathed to the university, the annual income to be applied for the purpose of promoting and encouraging scientific education or research in the university.

THE University of Aberdeen will celebrate the four hundredth anniversary of its foundation in the summer of 1906.

THE commissioner of agriculture for the Dominion of Canada, Mr. Robertson, will resign on January 1, to take charge of the new agricultural college established by Sir William MacDonald. According to the London *Times*, this will probably be the most complete agricultural college in the world. It is to be known as the Macdonald Foundation for Rural Education, the organization of which will be in the hands solely of Sir W. Macdonald and Mr. Robertson. It is to consist of three departments. The first will be for original research in bacteriology as applied to soils and products, in the biology of animals and plants, and in agricultural chemistry. The second will be a department of farms for the practical illustration of the discoveries in the research department, and the third will be a department of instruction combining a farm school and a college of agriculture. There will be residences for men and women students. The laboratories will be equipped in the most complete manner, and the best features of the principal agricultural colleges in Europe and America will be adopted. The amount of Sir W. Macdonald's benefaction is said on good authority to be not less than £1,000,000.

ON the occasion of the installation of Lord Kelvin as chancellor of the University of Glasgow, on November 29, the degree of LL.D. was conferred on Dr. James Thomson Bottomley, F.R.S., Arnott and Thomson demonstrator in experimental physics in the University for 24 years from 1875; Admiral Sir John Charles Dalrymple-Hay, F.R.S.; Mr. Guglielmo Marconi; and the Hon. Charles A. Parsons, F.R.S.

PROFESSOR WILLIAM G. RAYMOND, of the Rensselaer Polytechnic Institute, has been appointed professor of civil engineering and head of the departments of engineering in the Iowa State University at Iowa City. Professor Sherman M. Woodward, of the University of Arizona, has been called to the chair of steam engineering.

PROFESSOR HARRIS J. RYAN, of Cornell University, has been appointed professor of electrical engineering at Stanford University.

MR. ANDREW CARNEGIE has been reelected Lord Rector of the University of St. Andrews without opposition, Mr. Andrew Lang and Sir Henry Craik having declined to stand.

AUGUSTUS EDWARD HOUGH LOVE, M.A., D.C.L., F.R.S., Sedleian professor of natural philosophy at Oxford, formerly fellow of St. John's College, Cambridge, has been elected to an honorary fellowship at Queen's College.

MR. E. VERNER has been elected to a newly established chair of applied chemistry at the University of Dublin.

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*ON THE DEVELOPMENT OF MATHEMATICAL ANALYSIS AND ITS RELATIONS TO SOME OTHER SCIENCES.**

IT is one of the objects of a congress such as this which now brings us together, to show the bonds between the diverse parts of science taken in its most extended acceptation. So the organizers of this meeting have insisted that the relations between different sections should be put in evidence.

To undertake a study of this sort, somewhat indeterminate in character, it is necessary to forget that all is in all; in what concerns algebra and analysis, a Pythagorean would be dismayed at the extent of his task, remembering the celebrated formula of the school: 'Things are numbers.' From this point of view my subject would be inexhaustible.

But I, for the best of reasons, will make no such pretensions.

In casting merely a glance over the development of our science through the ages, and particularly in the last century, I hope to be able to characterize sufficiently the rôle of mathematical analysis in its relations to certain other sciences.

* Address at the International Congress of Arts and Science, St. Louis, September, 1904. Translated by George Bruce Halsted.

I.

It would appear natural to commence by speaking of the concept itself of whole number; but this subject is not alone of logical order, it is also of order historic and psychologic, and would draw us away into too many discussions.

Since the concept of number has been sifted, in it have been found unfathomable depths; thus, it is a question still pending to know, between the two forms, the cardinal number and the ordinal number, under which the idea of number presents itself, which of the two is anterior to the other, that is to say, whether the idea of number properly so called is anterior to that of order, or if it is the inverse.

It seems that the geometer-logician neglects too much in these questions psychology and the lessons uncivilized races give us; it would seem to result from these studies that the priority is with the cardinal number.

It may also be there is no general response to the question, the response varying according to races and according to mentalities.

I have sometimes thought, on this subject, of the distinction between auditives and visuals, auditives favoring the ordinal theory, visuals the cardinal.

But I will not linger on this ground full of snares; I fear that our modern school of logicians with difficulty comes to agreement with the ethnologists and biologists; these latter in questions of origin are always dominated by the evolution idea, and, for more than one of them, logic is only the résumé of ancestral experience. Mathematicians are even reproached with postulating in principle that there is a human mind in some way exterior to things, and that it has its logic. We must, however, submit to this, on pain of constructing nothing. We need this point of departure, and certainly, supposing it to have evolved during the course of prehistoric time, this logic of the human mind was perfectly fixed at the time of the oldest geometric schools, those of Greece; their works appear to have been its first code, as is expressed by the story of Plato writing over the door of his school 'Let no one not a geometer enter here.'

Long before the bizarre word algebra was derived from the Arabic, expressing, it would seem, the operation by which equalities are reduced to a certain canonic form, the Greeks had made algebra without knowing it; relations more intimate could not be imagined than those binding together their algebra and their geometry, or rather, one would be embarrassed to classify, if there were occasion, their geometric algebra, in which they reason not on numbers but on magnitudes.

Among the Greeks also we find a geometric arithmetic, and one of the most interesting phases of its development is the conflict which, among the Pythagoreans, arose in this subject between number and magnitude, apropos of irrationals.

Though the Greeks cultivated the abstract study of numbers, called by them arithmetic, their speculative spirit showed little taste for practical calculation, which they called logistic.

In remote antiquity, the Egyptians and the Chaldeans, and later the Hindus and the Arabs, carried far the science of calculation.

They were led on by practical needs; logistic preceded arithmetic, as land-surveying and geodesy opened the way to geometry; in the same way, trigonometry developed under the influence of the increasing needs of astronomy.

The history of science at its beginnings shows a close relation between pure and applied mathematics; this we will meet again constantly in the course of this study.

We have remained up to this point in the domain which ordinary language calls elementary algebra and arithmetic.

In fact, from the time that the incommensurability of certain magnitudes had been recognized, the infinite had made its appearance, and, from the time of the sophisms of Zeno on the impossibility of motion, the summation of geometric progressions must have been considered.

The procedures of exhaustion which are found in Eudoxus and in Euclid appertain already to the integral calculus, and Archimedes calculates definite integrals.

Mechanics also appeared in his treatise on the quadrature of the parabola, since he first finds the surface of the segment bounded by an arc of a parabola and its chord with the help of the theorem of moments; this is the first example of the relations between mechanics and analysis which since have not ceased developing.

The infinitesimal method of the Greek geometers for the measure of volumes raised questions whose interest is even today not exhausted.

In plane geometry, two polygons of the same area are either equivalent or equivalent-by-completion, that is to say, can be decomposed into a finite number of triangles congruent in pairs, or may be regarded as differences of polygons susceptible of such a partition.

It is not the same for the geometry of space, and we have lately learned that stereometry can not, like planimetry, get on without recourse to procedures of exhaustion or of limit, which require the axiom of continuity or the Archimedes assumption.

Without insisting further, this hasty glance at antiquity shows how completely then were amalgamated algebra, arithmetic, geometry and the first endeavors at integral calculus and mechanics, to the point of its being impossible to recall separately their history.

In the middle ages and the renaissance, the geometric algebra of the ancients separated from geometry. Little by little algebra properly so called arrived at independence, with its symbolism and its notation more and more perfected; thus was created this language so admirably clear, which brings about for thought a veritable economy and renders further progress possible.

This is also the moment when distinct divisions are organized.

Trigonometry which, in antiquity, had been only an auxiliary of astronomy is developed independently; toward the same time the logarithm appears, and essential elements are thus put in evidence.

II.

In the seventeenth century, the analytic geometry of Descartes, distinct from what I have just called the geometric algebra of the Greeks by the general and systematic ideas which are at its base, and the newborn dynamic were the origin of the greatest progress of analysis.

When Galileo, starting from the hypothesis that the velocity of heavy bodies in their fall is proportional to the time, from this deduced the law of the distances passed over, to afterward verify it by experiment, he took up again the road upon which Archimedes had formerly entered and on which would follow after him Cavalieri, Fermat and others still, even to Newton and Leibnitz. The integral calculus of the Greek geometers was born again in the kinematic of the great Florentine physicist.

As to the calculus of derivatives or of differentials, it was founded with precision apropos of the drawing of tangents.

In reality, the origin of the notion of derivative is in the confused sense of the mobility of things and of the rapidity more

or less great with which phenomena happen; this is well expressed by the words *fluents* and *fluxions*, which Newton used, and which one might suppose borrowed from old Heraclitus.

The points of view taken by the founders of the science of motion, Galileo, Huygens and Newton, had an enormous influence on the orientation of mathematical analysis.

It was with Galileo an intuition of genius to discover that, in natural phenomena, the determining circumstances of the motion produce accelerations: this must have conducted to the statement of the principle that the rapidity with which the dynamic state of a system changes depends in a determinate manner on its static state alone. In a more general way we reach the postulate that the infinitesimal changes, of whatever nature they may be, occurring in a system of bodies, depend uniquely on the actual state of this system.

In what degree are the exceptions apparent or real? This is a question which was raised only later and which I put aside for the moment.

From the principles enunciated becomes clear a point of capital importance for the analyst: Phenomena are ruled by differential equations which can be formed when observation and experiment have made known for each category of phenomena certain physical laws.

We understand the unlimited hopes conceived from these results. As Bertrand says in the preface of his treatise, 'the early successes were at first such that one might suppose all the difficulties of science surmounted in advance, and believe that the geometers, without being longer distracted by the elaboration of pure mathematics, could turn their meditations exclusively toward the study of the natural laws.'

This was to admit gratuitously that the problems of analysis, to which one was led, would not present very grave difficulties.

Despite the disillusions the future was to bring, this capital point remained, that the problems had taken a precise form, and that a classification could be established in the difficulties to be surmounted.

There was, therefore, an immense advance, one of the greatest ever made by the human mind. We understand also why the theory of differential equations acquired a considerable importance.

I have anticipated somewhat, in presenting things under a form so analytic. Geometry was intermingled in all this progress. Huygens, for example, followed always by preference the ancients, and his 'Horologium oscillatorium' rests at the same time on infinitesimal geometry and mechanics; in the same way, in the 'Principia' of Newton, the methods followed are synthetic.

It is above all with Leibnitz that science takes the paths which were to lead to what we call mathematical analysis; it is he who, for the first time, in the latter years of the seventeenth century, pronounces the word function.

By his systematic spirit, by the numerous problems he treated, even as his disciples James and John Bernoulli, he established in a final way the power of the doctrines to the edification of which had successively contributed a long series of thinkers from the distant times of Eudoxus and of Archimedes.

The eighteenth century showed the extreme fecundity of the new methods. That was a strange time, the era of mathematical duels where geometers hurled defiance, combats not always without acrimony, when Leibnitzians and Newtonians encountered in the lists.

From the purely analytic point of view, the classification and study of simple functions is particularly interesting; the func-

tion idea, on which analysis rests, is thus developed little by little.

The celebrated works of Euler hold then a considerable place. However, the numerous problems which present themselves to the mathematicians leave no time for a scrutiny of principles; the foundations themselves of the doctrine are elucidated slowly, and the *mot* attributed to d'Alembert 'allez en avant et la foi vous viendra' is very characteristic of this epoch.

Of all the problems started at the end of the seventeenth century or during the first half of the eighteenth, it will suffice for me to recall those isoperimetric problems which gave birth to the calculus of variations.

I prefer to insist on the interpenetration still more intimate between analysis and mechanics when, after the inductive period of the first age of dynamics, the deductive period was reached where one strove to give a final form to the principles. The mathematical and formal development played then the essential rôle, and the analytic language was indispensable to the greatest extension of these principles.

There are moments in the history of the sciences and, perhaps, of society, when the spirit is sustained and carried forward by the words and the symbols it has created, and when generalizations present themselves with the least effort. Such was particularly the rôle of analysis in the formal development of mechanics.

Allow me a remark just here. It is often said an equation contains only what one has put in it. It is easy to answer, first, that the new form under which one finds the things constitutes often of itself an important discovery.

But sometimes there is more; analysis, by the simple play of its symbols, may suggest generalizations far surpassing the primitive outline. Is it not so with the principle of virtual velocities, of which the first idea comes from the simplest mechanisms; the analytic form which translates it will suggest extensions leading far from the point of departure.

In the same sense, it is not just to say analysis has created nothing, since these more general conceptions are its work. Still another example is furnished us by Lagrange's system of equations; here calculus transformations have given the type of differential equations to which one tends to carry back to-day the notion of mechanical explanation.

There are in science few examples comparable to this, of the importance of the form of an analytic relation and of the power of generalization of which it may be capable.

It is very clear that, in each case, the generalizations suggested should be made precise by an appeal to observation and experiment, then it is still the calculus which searches out distant consequences for checks, but this is an order of ideas which I need not broach here.

Under the impulse of the problems set by geometry, mechanics and physics, we see develop or take birth almost all the great divisions of analysis. First were met equations with a single independent variable. Soon appear partial differential equations, with vibrating cords, the mechanics of fluids and the infinitesimal geometry of surfaces.

This was a wholly new analytic world; the origin itself of the problems treated was an aid which from the first steps permits no wandering, and in the hands of Monge geometry rendered useful services to the new-born theories.

But of all the applications of analysis, none had then more renown than the problems of celestial mechanics set by the knowledge of the law of gravitation and to which the greatest geometers gave their names.

Theory never had a more beautiful triumph; perhaps one might add that it was too complete, because it was at this moment above all that were conceived for natural philosophy the hopes at least premature of which I spoke above.

In all this period, especially in the second half of the eighteenth century, what strikes us with admiration and is also somewhat confusing, is the extreme importance of the applications realized, while the pure theory appeared still so ill assured. One perceives it when certain questions are raised like the degree of arbitrariness in the integral of vibrating cords, which gives place to an interminable and inconclusive discussion.

Lagrange appreciated these insufficiencies when he published his theory of analytic functions where he strove to give a precise foundation to analysis.

One can not too much admire the marvelous presentiment he had of the rôle which were to play the functions we call, with him, analytic; but we may confess that we stand astonished before the demonstration he believed to have given of the possibilty of the development of a function in Taylor's series.

The exigencies in questions of pure analysis were less at this epoch. Confiding in intuition, one was content with certain probabilities and agreed implicitly about certain hypotheses that it seemed useless to formulate in an explicit way; in reality, one had confidence in the ideas which so many times had shown themselves fecund, which is very nearly the *mot* of d'Alembert.

The demand for rigor in mathematics has had its successive approximations, and in this regard our sciences have not the absolute character so many people attribute to them.

III.

We have now reached the first years of the nineteenth century. As we have explained, the great majority of the analytic researches had, in the eighteenth century, for occasion a problem of geometry, and especially of mechanics and of physics, and we have scarcely found the logical and esthetic preoccupations which are to give a physiognomy so different to so many mathematical works, above all in the latter two thirds of the nineteenth century.

Not to anticipate, however, after so many examples of the influences of physics on the developments of analysis, we meet still a new one, and one of the most memorable, in Fourier's theory of heat. He commences by forming the partial differential equations which govern temperature.

What are for a partial differential equation the conditions at the limits permitting the determination of a solution?

For Fourier, the conditions are suggested by the physical problem and the methods that he followed have served as models to the physicist-geometers of the first half of the last century.

One of these consists in forming a series with certain simple solutions. Fourier thus obtained the first types of developments more general than the trigonometric developments, as in the problem of the cooling of a sphere, where he applies his theory to the terrestrial globe, and investigates the law which governs the variations of temperature in the ground, trying to go even as far as numerical applications.

In the face of so many beautiful results, we understand the enthusiasm of Fourier which scintillates from every line of his preliminary discourse. Speaking of mathematical analysis, he says, "there could not be a language more universal, more simple, more exempt from errors and from obscurities, that is to say, more worthy to express

the invariable relations of natural things. Considered under this point of view, it is as extended as nature herself; it defines all sensible relations, measures times, spaces, forces, temperatures. This difficult science forms slowly, but it retains all the principles once acquired. It grows and strengthens without cease in the midst of so many errors of the human mind."

The elegy is magnificent, but permeating it we see the tendency which makes all analysis uniquely an auxiliary, however incomparable, of the natural sciences, a tendency, in conformity, as we have seen, with the development of science during the preceding two centuries; but we reach just here an epoch where new tendencies appear.

Poisson having in a report on the Fundamenta recalled the reproach made by Fourier to Abel and Jacobi of not having occupied themselves preferably with the movement of heat, Jacobi wrote to Legendre: 'It is true that Monsieur Fourier held the view that the principal aim of mathematics was public utility, and the explanation of natural phenomena; but a philosopher such as he should have known that the unique aim of science is the honor of the human spirit, and that from this point of view, a question about numbers is as important as a question about the system of the world.' This was without doubt also the opinion of the grand geometer of Goettingen, who called mathematics the queen of the sciences, and arithmetic the queen of mathematics.

It would be ridiculous to oppose one to the other these two tendencies; the harmony of our science is in their synthesis.

The time was about to arrive when one would feel the need of inspecting the foundations of the edifice, and of making the inventory of accumulated wealth, using more of the critical spirit. Mathematical thought was about to gather more force by retiring into itself; the problems were exhausted for a time, and it is not well for all seekers to stay on the same road. Moreover, difficulties and paradoxes remaining unexplained made necessary the progress of pure theory.

The path on which this should move was traced in its large outlines, and there it could move with independence without necessarily losing contact with the problems set by geometry, mechanics and physics.

At the same time more interest was to attach to the philosophic and artistic side of mathematics, confiding in a sort of preestablished harmony between our logical and esthetic satisfactions and the necessities of future applications.

Let us recall rapidly certain points in the history of the revision of principles where Gauss, Cauchy and Abel likewise were laborers of the first hour. Precise definitions of continuous functions, and their most immediate properties, simple rules on the convergence of series, were formulated; and soon was established under very general conditions, the possibility of trigonometric developments, legitimatizing thus the boldness of Fourier.

Certain geometric intuitions relative to areas and to arcs give place to rigorous demonstration. The geometers of the eighteenth century had necessarily sought to give account of the degree of the generality of the solution of ordinary differential equations. Their likeness to equations of finite differences led easily to the result; but the demonstration so conducted must not be pressed very close.

Lagrange, in his lessons on the calculus of functions had introduced greater precision, and starting from Taylor's series, he saw that the equation of order m leaves indeterminate the function, and its $m - 1$ first derivatives for the initial value of the variable; we are not surprised that La-

grange did not set himself the question of convergence.

In twenty or thirty years the exigencies in the rigor of proofs had grown. One knew that the two preceding modes of demonstration are susceptible of all the precision necessary.

For the first, there was need of no new principle; for the second it was necessary that the theory should develop in a new way. Up to this point, the functions and the variables had remained real. The consideration of complex variables comes to extend the field of analysis. The functions of a complex variable with unique derivative are necessarily developable in Taylor's series; we come back thus to the mode of development of which the author of the theory of analytic functions had understood the interest, but of which the importance could not be put fully in evidence in limiting oneself to real variables. They also owe the grand rôle that they have not ceased to play to the facility with which we can manage them, and to their convenience in calculation.

The general theorems of the theory of analytic functions permitted to reply with precision to questions remaining up to that time undecided, such as the degree of generality of the integrals of differential equations. It became possible to push even to the end the demonstration sketched by Lagrange for an ordinary differential equation. For a partial differential equation or a system of such equations, precise theorems were established. It is not that on this latter point the results obtained, however important they may be, resolve completely the diverse questions that may be set; because in mathematical physics, and often in geometry, the conditions at the limits are susceptible of forms so varied that the problem called Cauchy's appears often under very severe form. I will shortly return to this capital point.

IV.

Without restricting ourselves to the historic order, we will follow the development of mathematical physics during the last century, in so far as it interests analysis.

The problems of calorific equilibrium lead to the equation already encountered by Laplace in the study of attraction. Few equations have been the object of so many works as this celebrated equation. The conditions at the limits may be of divers forms. The simplest case is that of the calorific equilibrium of a body of which we maintain the elements of the surface at given temperatures; from the physical point of view, it may be regarded as evident that the temperature, continuous within the interior since no source of heat is there, is determined when it is given at the surface.

A more general case is that where, the state remaining permanent, there might be radiation toward the outside with an emissive power varying on the surface in accordance with a given law; in particular the temperature may be given on one portion, while there is radiation on another portion.

These questions, which are not yet resolved in their greatest generality, have greatly contributed to the orientation of the theory of partial differential equations. They have called attention to types of determinations of integrals, which would not have presented themselves in remaining at a point of view purely abstract.

Laplace's equation had been met already in hydrodynamics and in the study of attraction inversely as the square of the distance. This latter theory has led to putting in evidence the most essential elements such as the potentials of simple strata and of double strata. Analytic combinations of the highest importance were there met, which since have been notably generalized, such as Green's formula.

The fundamental problems of static electricity belong to the same order of ideas, and that was surely a beautiful triumph for theory, the discovery of the celebrated theorem on electric phenomena in the interior of hollow conductors, which later Faraday rediscovered experimentally, without having known of Green's memoir.

All this magnificent ensemble has remained the type of the theories already old of mathematical physics, which seem to us almost to have attained perfection, and which exercise still so happy an influence on the progress of pure analysis in suggesting to it the most beautiful problems. The theory of functions offers us another memorable affiliation.

There the analytic transformations which come into play are not distinct from those we have met in the permanent movement of heat. Certain fundamental problems of the theory of functions of a complex variable lost then their abstract enunciation to take a physical form, such as that of the distribution of temperature on a closed surface of any connection and not radiating, in calorific equilibrium with two sources of heat which necessarily correspond to flows equal and of contrary signs. Transposing, we face a question relative to Abelian integrals of the third species in the theory of algebraic curves.

The examples which precede, where we have envisaged only the equations of heat and of attraction, show that the influence of physical theories has not been exercised only on the general nature of the problems to be solved, but even in the details of the analytic transformations. Thus is currently designated in recent memoirs on partial differential equations under the name of Green's formula, a formula inspired by the primitive formula of the English physicist. The theory of dynamic electricity and that of magnetism, with Ampère and Gauss, have been the origin of important progress; the study of curvilinear integrals and that of the integrals of surfaces have taken thence all their developments, and formulas, such as that of Stokes which might also be called Ampère's formula, have appeared for the first time in memoirs on physics. The equations of the propagation of electricity, to which are attached the names of Ohm and Kirchoff, while presenting a great analogy with those of heat, offer often conditions at the limits a little different; we know all that telegraphy by cables owes to the profound discussion of a Fourier's equation carried over into electricity.

The equations long ago written of hydrodynamics, the equations of the theory of electricity, those of Maxwell and of Hertz in electromagnetism have offered problems analogous to those recalled above, but under conditions still more varied. Many unsurmounted difficulties are there met with; but how many beautiful results we owe to the study of particular cases, whose number one would wish to see increase. To be noted also as interesting at once to analysis and physics are the profound differences which the propagation may present according to the phenomena studied. With equations such as those of sound, we have propagation by waves; with the equation of heat, each variation is felt instantly at every distance, but very little at a very great distance, and we can not then speak of velocity of propagation.

In other cases of which Kirchoff's equation relative to the propagation of electricity with induction and capacity offers the simplest type, there is a wave front with a velocity determined but with a remainder behind which does not vanish.

These diverse circumstances reveal very different properties of integrals; their study has been delved into only in a few particular cases, and it raises questions

into which enter the most profound notions of modern analysis.

V.

I will enter into certain analytic details especially interesting for mathematical physics.

The question of the generality of the solution of a partial differential equation has presented some apparent paradoxes. For the same equation, the number of arbitrary functions figuring in the general integral was not always the same, following the form of the integral envisaged. Thus Fourier, studying the equation of heat in an indefinite medium, considers as evident that a solution will be determined if its value for $t = 0$ is given, that is to say one arbitrary function of the three coordinates x, y, z; from the point of view of Cauchy, we may consider, on the contrary, that in the general solution there are two arbitrary functions of the three variables. In reality, the question, as it has long been stated, has not a precise signification.

In the first place, when it is a question only of analytic functions, any finite number of functions of any number of independent variables presents, from the arithmetical point of view, no greater generality than a single function of a single variable, since in the one case and in the other the ensemble of coefficients of the development forms an enumerable series. But there is something more. In reality, beyond the conditions which are translated by given functions, an integral is subjected to conditions of continuity, or is to become infinite in a determined manner for certain elements; one may so be led to regard as equivalent to an arbitrary function the condition of continuity in a given space, and then we clearly see how badly formulated is the question of giving the number of the arbitrary functions. It is at times a delicate matter to demonstrate that conditions determine in a unique manner a solution, when we do not wish to be contented with probabilities; it is then necessary to make precise the manner in which the function and certain of its derivatives conduct themselves.

Thus in Fourier's problem relative to an indefinite medium certain hypotheses must be made about the function and its first derivatives at infinity, if we wish to establish that the solution is unique.

Formulas analogous to Green's render great services, but the demonstrations one deduces from them are not always entirely rigorous, implicitly supposing fulfilled for the limits conditions which are not, *a priori* at least, necessary. This is, after so many others, a new example of the evolution of exigencies in the rigor of proofs.

We remark, moreover, that the new study, rendered necessary, has often led to a better account of the nature of integrals.

True rigor is fecund, thus distinguishing itself from another purely formal and tedious, which spreads a shadow over the problems it touches.

The difficulties in the demonstration of the unity of a solution may be very different according as it is question of equations of which all the integrals are or are not analytic. This is an important point, and shows that even when we wish to put them aside, it is necessary sometimes to consider non-analytic functions.

Thus we can not affirm that Cauchy's problem determines in a unique manner, one solution, the data of the problem being general, that is to say not being characteristic.

This is surely the case, if we envisage only analytic integrals, but with non-analytic integrals, there may be contacts of order infinite. And theory here does not outstrip applications; on the contrary, as the following example shows:

Does the celebrated theorem of Lagrange

on the potentials of velocity in a perfect fluid hold good in a viscid fluid? Examples have been given where the coordinates of different points of a viscous fluid starting from rest are not expressible as analytic functions of the time starting from the initial instant of the motion, and where the nul rotations as well as all their derivatives with respect to the time at this instant are, however, not identically nul; Lagrange's theorem, therefore, does not hold true.

These considerations sufficiently show the interest it may have to be assured that all the integrals of a system of partial differential equations continuous as well as all their derivatives up to a determined order in a certain field of real variables are analytic functions; it is understood, we suppose, there are in the equations only analytic elements. We have for linear equations precise theorems, all the integrals being analytic, if the characteristics are imaginary, and very general propositions have also been obtained in other cases.

The conditions at the limits that one is led to assume are very different according as it is question of an equation of which the integrals are or are not analytic. A type of the first case is given by the problem generalized by Dirichlet; conditions of continuity there play an essential part, and, in general, the solution can not be prolonged from the two sides of the continuum which serves as support to the data; it is no longer the same in the second case, where the disposition of this support in relation to the characteristics plays the principal rôle, and where the field of existence of the solution presents itself under wholly different conditions.

All these notions, difficult to make precise in ordinary language and fundamental for mathematical physics, are not of less interest for infinitesimal geometry.

It will suffice to recall that all the surfaces of constant positive curvature are analytic, while there exist surfaces of constant negative curvature not analytic.

From antiquity has been felt the confused sentiment of a certain economy in natural phenomena; one of the first precise examples is furnished by Fermat's principle relative to the economy of time in the transmission of light.

Then we came to recognize that the general equations of mechanics correspond to a problem of minimum, or more exactly of variation, and thus we obtained the principle of virtual velocities, then Hamilton's principle, and that of least action. A great number of problems appeared then as corresponding to minima of certain definite integrals.

This was a very important advance, because the existence of a minimum could in many cases be regarded as evident, and consequently the demonstration of the existence of the solution was effected.

This reasoning has rendered immense services; the greatest geometers, Gauss in the problem of the distribution of an attracting mass corresponding to a given potential, Riemann in his theory of Abelian functions, have been satisfied with it. To-day our attention has been called to the dangers of this sort of demonstration; it is possible for the minima to be simply limits and not to be actually attained by veritable functions possessing the necessary properties of continuity. We are, therefore, no longer content with the probabilities offered by the reasoning long classic.

Whether we proceed indirectly or whether we seek to give a rigorous proof of the existence of a function corresponding to the minimum, the route is long and arduous.

Further, not the less will it be always useful to connect a question of mechanics or of mathematical physics with a problem of minimum; in this first of all is a source of fecund analytic transformations, and be-

sides in the very calculations of the investigation of variations useful indications may appear, relative to the conditions at the limits; a beautiful example of it was given by Kirchoff in the delicate investigation of the conditions at the limits of the equilibrium of flexure of plates.

VI.

I have been led to expand particularly on partial differential equations.

Examples chosen in rational mechanics and in celestial mechanics would readily show the rôle which ordinary differential equations play in the progress of these sciences whose history, as we have seen, has been so narrowly bound to that of analysis.

When the hope of integrating with simple functions was lost, one strove to find developments permitting to follow a phenomenon as long as possible, or at least to obtain information of its qualitative bearing.

For practise, the methods of approximation form an extremely important part of mathematics, and it is thus that the highest parts of theoretic arithmetic find themselves connected with the applied sciences. As to series, the demonstrations themselves of the existence of integrals furnish them from the very first; thus Cauchy's first method gives developments convergent as long as the integrals and the differential coefficients remain continuous.

When any circumstance permits our foreseeing that such is always the case, we obtain developments always convergent. In the problem of n bodies, we can in this way obtain developments valid so long as there are no shocks.

If the bodies, instead of attracting, repel each other, this contingency need not be feared and we would obtain developments valid indefinitely; unhappily, as Fresnel said one day to Laplace, nature is not concerned about analytic difficulties and the celestial bodies attract instead of repelling each other.

One would even be tempted at times to go further than the great physicist and say that nature has sown difficulties in the paths of the analysts.

Thus to take another example, we can generally decide, given a system of differential equations of the first order, whether the general solution is stable or not about a point, and to find developments in series valid for stable solutions it is only necessary that certain inequalities be verified.

But if we apply these results to the equations of dynamics to discuss stability, we find ourselves exactly in the particular case which is unfavorable. Nay, in general here it is not possible to decide on the stability; in the case of a function of forces having a maximum, reasoning classic, but indirect, establishes the stability which can not be deduced from any development valid for every value of the time.

Do not lament these difficulties; they will be the source of future progress.

Such are also the difficulties which still present to us, in spite of so many works, the equations of celestial mechanics; the astronomers have almost drawn from them, since Newton, by means of series practically convergent and approximations happily conducted all that is necessary for the foretelling of the motions of the heavenly bodies.

The analysts would ask more, but they no longer hope to attain the integration by means of simple functions or developments always convergent.

What admirable recent researches have best taught them is the immense difficulty of the problem; a new way has, however, been opened by the study of particular solutions, such as the periodic solutions and the asymptotic solutions which have already been utilized. It is not perhaps

so much because of the needs of practice as in order not to avow itself vanquished, that analysis will never resign itself to abandon, without a decisive victory, a subject where it has met so many brilliant triumphs; and again, what more beautiful field could the theories new-born or rejuvenated of the modern doctrine of functions find, to essay their forces, than this classic problem of n bodies?

It is a joy for the analyst to encounter in applications equations that he can integrate with known functions, with transcendents already classed.

Such encounters are unhappily rare; the problem of the pendulum, the classic cases of the motion of a solid body around a fixed point are examples where the elliptic functions have permitted us to effect the integration.

It would also be extremely interesting to encounter a question of mechanics which might be the origin of the discovery of a new transcendent possessing some remarkable property; I would be embarrassed to give an example of it unless in carrying back to the pendulum the début of the theory of elliptic functions.

The interpenetration between theory and applications is here much less than in the questions of mathematical physics. Thus is explained, that, since forty years, the works on ordinary differential equations attached to analytic functions have had in great part a theoretic character altogether abstract.

The pure theory has notably taken the advance; we have had occasion to say that it was well it should be so, but evidently there is here a question of measure, and we may hope to see the old problems profit by the progress accomplished.

It would not be over difficult to give some examples, and I will recall only those linear differential equations, where figure arbitrary parameters whose singular values are roots of entire transcendent functions; which in particular makes the successive harmonics of a vibrating membrane correspond to the poles of a meromorphic function.

It happens also that the theory may be an element of classification in leading to seek conditions for which the solution falls under a determined type, as for example that the integral may be uniform. There have been and there yet will be many interesting discoveries in this way, the case of the motion of a solid heavy body treated by Mme. de Kovalevski and where the Abelian functions were utilized is a remarkable example.

VII.

In studying the reciprocal relations of analysis with mechanics and mathematical physics, we have on our way more than once encountered the infinitesimal geometry, which has proposed so many celebrated problems; in many difficult questions, the happy combination of calculus and synthetic reasonings has realized considerable progress, as show the theories of applicable surfaces and systems triply orthogonal.

It is another part of geometry which plays a grand rôle in certain analytic researches, I mean the geometry of situation or *analysis situs*. We know that Riemann made from this point of view a complete study of the continuum of two dimensions, on which rests his theory of algebraic functions and their integrals.

When this number of dimensions augments, the questions of *analysis situs* become necessarily complicated; the geometric intuition ceases, and the study becomes purely analytic, the mind being guided solely by analogies which may be misleading and need to be discussed very closely. The theory of algebraic functions of two variables, which transports us into a space of four dimensions, without getting from

analysis situs an aid so fruitful as does the theory of functions of one variable, owes it, however, useful orientations.

There is also another order of questions where the geometry of situation intervenes; in the study of curves traced on a surface and defined by differential equations, the connection of this surface plays an important rôle; this happens for geodesic lines.

The notion of connexity, moreover, presented itself long ago in analysis, when the study of electric currents and magnetism led to non-uniform potentials; in a more general manner certain multiform integrals of some partial differential equations are met in difficult theories, such as that of diffraction, and varied researches must continue in this direction.

From a different point of view, I must yet recall the relations of algebraic analysis with geometry, which manifest themselves so elegantly in the theory of groups of finite order.

A regular polyhedron, say an icosahedron, is on the one hand the solid that all the world knows; it is also, for the analyst, a group of finite order, corresponding to the divers ways of making the polyhedron coincide with itself.

The investigation of all the types of groups of motion of finite order interests not alone the geometers, but also the crystallographers; it goes back essentially to the study of groups of ternary linear substitutions of determinant $+1$, and leads to the thirty-two systems of symmetry of the crystallographers for the particular complex.

The grouping in systems of polyhedra corresponding so as to fill space exhausts all the possibilities in the investigation of the structure of crystals.

Since the epoch when the notion of group was introduced into algebra by Galois, it has taken, in divers ways, considerable development, so that to-day it is met in all parts of mathematics. In the applications, it appears to us above all as an admirable instrument of classification. Whether it is a question of substitution groups or of Sophus Lie's transformation groups, whether it is a question of algebraic equations or of differential equations this comprehensive doctrine permits explanation of the degree of difficulty of the problems treated and teaches how to utilize the special circumstances which present themselves; thus it should interest as well mechanics and mathematical physics as pure analysis.

The degree of development of mechanics and physics has permitted giving to almost all their theories a mathematical form; certain hypotheses, the knowledge of elementary laws, have led to differential relations which constitute the last form under which these theories settle down, at least for a time. These latter have seen little by little their field enlarge with the principles of thermodynamics; to-day chemistry tends to take in its turn a mathematical form.

I will take as witness of it only the celebrated memoir of Gibbs on the equilibrium of chemical systems, so analytic in character, and where it needed some effort on the part of the chemists to recognize, under their algebraic mantle, laws of high importance.

It seems that chemistry has to-day gotten out of the prematheматic period, by which every science begins, and that a day must come when will be systematized grand theories, analogous to those of our present mathematical physics, but far more vast, and comprising the ensemble of physico-chemic phenomena.

It would be premature to ask if analysis will find in their developments the source

of new progress; we do not even know beforehand what analytic types one might find.

I have constantly spoken of differential equations ruling phenomena; will this always be the final form which condenses a theory? Of this I know nothing certain, but we should, however, remember that many hypotheses have been made of nature more or less experimental; among them, one is what has been called the principle of *non-heredity*, which postulates that the future of a system depends only on its present state and its state at an instant infinitely near, or more briefly that accelerations depend only on positions and velocities.

We know that in certain cases this hypothesis is not admissible, at least with the magnitudes directly envisaged; one has sometimes misemployed on this subject the memory of matter, which recalls its past, and has spoken in affected terms of the life of a morsel of steel. Different attempts have been made to give a theory of these phenomena, where a distant past seems to interfere; of them I need not speak here. An analyst may think that in cases so complex it is necessary to abandon the form of differential equations, and resign oneself to envisage *functional equations*, where figure definite integrals which will be the witness of a sort of heredity.

To see the interest which is attached at this moment to functional equations, one might believe in a presentiment of the future needs of science.

VIII.

After having spoken of non-heredity, I scarcely dare touch the question of the applications of analysis to biology.

It will be some time, no doubt, before one forms the functional equations of biologic phenomena; the attempts so far made are in a very modest order of ideas; yet efforts are being made to get out of the purely qualitative field, to introduce quantitative measures. In the question of the variation of certain characteristics, mensuration has been engaged in, and statistic measures which are translated by curves of frequency. The modifications of these curves with successive generations, their decompositions into distinct curves, may give the measure of the stability of species or of the rapidity of mutations, and we know what interest attaches itself to these questions in recent botanic researches. In all this so great is the number of parameters that one questions whether the infinitesimal method itself could be of any service. Some laws of a simple arithmetic character like those of Mendel come occasionally to give renewed confidence in the old aphorism which I cited in the beginning, that all things are explained by numbers; but, in spite of legitimate hopes, it is clear that, in its totality, biology is still far from entering upon a period truly mathematical.

It is not so, according to certain economists, with potential economy. After Cournot, the Lausanne school made an effort extremely interesting to introduce mathematical analysis into political economy.

Under certain hypotheses, which fit at least limiting cases, we find in learned treatises an equation between the quantities of merchandise and their prices, which recalls the equation of virtual velocities in mechanics: this is the equation of economic equilibrium. A function of quantities plays in this theory an essential rôle recalling that of the potential function. Moreover, the best authorized representatives of the school insist on the analogy of economic phenomena with mechanical phenomena. "As rational mechanics, says one of them, considers material points, pure economy considers the homo œconomicus."

Naturally, we find there also the ana-

logues of Lagrange's equations, indispensable matrix of all mechanics.

While admiring these bold works, we fear lest the authors have neglected certain hidden masses, as Helmholtz and Hertz would have said. But although that may happen, there is in these doctrines a curious application of mathematics, which, at least in well-circumscribed cases, has already rendered great services.

I have terminated, messieurs, this summary history of some of the applications of analysis, with the reflections which it has at moments suggested to me.

It is far from being complete; thus I have omitted to speak of the calculus of probabilities, which demands so much subtlety of mind, and of which Pascal refused to explain the niceties to the chevalier de Méré because he was not a geometer.

Its practical utility is of the first rank, its theoretic interest has always been great; it is further augmented to-day, thanks to the importance taken by the researches that Maxwell called *statistical* and which tend to envisage mechanics under a wholly new light.

I hope, however, to have shown, in this sketch, the origin and the reason of the bonds so profound which unite analysis to geometry and physics, more generally to every science bearing on quantities numerically measurable.

The reciprocal influence of analysis and physical theories has been in this regard particularly instructive.

What does the future reserve?

Problems more difficult, corresponding to an approximation of higher order, will introduce complications which we can only vaguely forecast, in speaking, as I have just done, of functional equations replacing systematically our actual differential equations, or further of integrations of equations infinite in number with an infinity of unknown functions. But even though that happens, mathematical analysis will always remain that language which, according to the *mot* of Fourier, has no symbols to express confused notions, a language endowed with an admirable power of transformation and capable of condensing in its formulas a number immense of results.

Emile Picard.

PRESENT PROBLEMS OF METEOROLOGY.[*]

Never in the history of the science have so many problems presented themselves for solution as at the present time. Numerous *a priori* theories require demonstration and, in fact, the whole structure of meteorology, which has been erected on hypotheses, needs to be strengthened or rebuilt by experimental evidence. Until recently the observations have been carried on at the very bottom of the atmosphere and our predecessors have been compared justly to shell-fish groping about the abysses of the ocean floor to which they are confined.

Probably meteorology had its origin in a crude system of weather predictions, based on signs in the heavens, and it did not become a science until the invention of the principal meteorological instruments in the seventeenth century made possible the study of climatology by the collection of exact and comparable observations at many places on the globe. These data, owing to extensive operations of the meteorological services in the different countries, are now tolerably complete, there being comparatively small portions of the land-surface, at least, for which the climatic elements are not fairly well known, the gaps that remain to be filled lying chiefly on the Antarctic continent and in the interior of Africa.

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[*] Address at St. Louis to the Section of Cosmical Physics of the International Congress of Arts and Science.

over a considerable territory, were telegraphed to a central office for the purpose of forecasting the weather, it must be confessed that practically no progress has been realized in this art, for, while much has been done to complete and extend the area under observation by the creation of a finer and larger network of stations, and while the transmission of the observations and the dissemination of the forecasts based on them have been accelerated, the methods employed in formulating the forecasts are essentially those empirical rules which were adopted at the inception of the work. A recent extension of the field of observation over the ocean, by wireless telegraphy, may here be mentioned as offering advantages to certain countries; for example, the reports now being received in England from steamers in mid-Atlantic give information about the approaching weather conditions—subject, of course, to any subsequent changes—long before they reach the western shores of the British Isles. Nevertheless, the data obtained still relate mainly to the lowest strata of the atmosphere and we are ignorant of the conditions that prevail at the height of a mile or two both during storms and in fine weather. Until these are known and their sequence in the upper and lower atmosphere has been established by careful investigation, our weather forecasts based on synoptic observations will continue to be largely empirical. However, it should be remembered that since weather predictions constitute the aspect of meteorology which most appeals to mankind, the incentive to improve them is the most likely to stimulate the investigations needed. Therefore, it is the problems of dynamic meteorology that now press for solution, and to achieve this purpose we must not only look upward, but also elevate ourselves, or our instruments, into the higher regions.

This mode of study belongs entirely to the last half-century, for only within that period has a systematic attempt been made to ascertain the conditions prevailing in the upper air. To the credit of the United States it should be remembered that the first post of observation upon a mountain peak was one established in 1871 upon Mount Washington, in New Hampshire, and this was soon followed by the highest observatory in the world, maintained during fifteen years upon the summit of Pike's Peak in Colorado. The observatory upon the Puy de Dôme in France, opened in 1876, was the first mountain station in Europe to be equipped with self-recording instruments. A large amount of data has been collected at these stations which illustrate chiefly the climatology of the mountainous regions, for what we obtain in this way still pertains to the earth and, as is now admitted, does not represent the conditions prevailing at an equal height in the free air. During the present century, the organized efforts which have been made to explore the ocean of air above us have already resulted in a great increase of knowledge respecting the atmosphere as a whole. This task of ascertaining the conditions of the free air was resumed in 1888, with balloon ascents in Germany, in which special precautions were taken to obtain accurate temperatures, previous observations in balloons leaving much to be desired in this respect. In France, about 1892, it was demonstrated that by means of balloons carrying only self-recording instruments, meteorological information might be acquired at heights far greater than those to which a human being can hope to ascend and live. The use of the so-called *'ballons-sondes,'* liberated and abandoned to their fate, with the expectation that when they fall to the ground the records will be reco[illegible] soon adopted in Germany ε

all over Europe. It has been introduced into the United States by the writer, who has just despatched the first of these registration-balloons from St. Louis, hoping in this way to obtain the temperatures at heights never before reached above the American continent.

In 1894, at the Blue Hill Observatory, near Boston, kites were first used to lift self-recording instruments and so obtain graphical records of the various meteorological elements in the free air, and this method of observation, which presents the great advantage of securing the data in the different atmospheric strata almost simultaneously and nearly vertically above the station on the ground, has been extensively employed both in this country and abroad. Heights exceeding three miles have been attained and it is possible to ascend a mile or two on almost any day when there is wind. To render the method independent of this factor, the plan of flying kites from a steamship was introduced by the writer three years ago, and this scheme, too, is now being successfully employed in Europe. The exploration of the free air by balloons and kites, it may be remarked, has given rise to the construction of special types of light and simple self-recording instruments, which are capable of recording automatically the values of temperature, moisture and wind with a precision comparable to the eye-readings of standard instruments by a good observer.

Having described some of the newer methods of meteorological investigation, let us now consider how they may help to solve certain problems in dynamic meteorology. It should be premised that, since the atmosphere is relatively a thin layer with respect to the globe which it covers, no portion of it can be regarded as independent of another and, consequently, a weather-map of the whole globe, day by day, is of prime importance. Were this provided, the atmospheric changes occurring simultaneously in both hemispheres could be watched and their relation to what have been called 'the great centers of action,' investigated. Thanks to the increasing area covered by reports from the various weather services, the unmapped surface of the globe is being diminished, so that a complete picture of the state of the atmosphere each day over the land is gradually coming into view.

The mathematical application of the theory of a rotating sphere, surrounded by a heated atmosphere, to explain the circulation of the atmosphere as we find it, has not been satisfactory, owing to our lack of knowledge of the conditions of the upper air, as well as our ignorance concerning the physical properties of the atmosphere itself. To acquire the latter knowledge, research laboratories must be established at selected points, at both high and low levels, and as subjects of study there may be mentioned the determination of the amount of heat received from the sun and its secular variation, if any, the radiating and absorbing power of the air, the relation of pressure, density and temperature, the chemical composition of the air, its ionization and radioactivity, and other investigations which have been proposed by Professors Abbe and McAdie in their pleas for the creation of such aerophysical laboratories. The observatory now under construction by the United States Weather Bureau on a mountain in Virginia will, it is hoped, enable some of these problems to receive the attention which they deserve.

The average circulation of the lower atmosphere is now well known, by reason of the monumental work of Lieutenant Maury on the winds over the oceans, and from the mass of data since collected over oceans and continents through the meteorological organizations of the various coun-

tries. While, naturally, much less is known regarding the circulation of the upper air, a great deal has been ascertained from the observations of clouds that were instituted a few years ago in various parts of the world by an international committee. In order to insure that the same cloud should everywhere be called by the same name, it was necessary to instruct the observers by publishing a cloud-atlas, containing pictures and descriptions of the typical forms of clouds which experience has shown to be identical all over the globe. Then during one year which had been agreed upon, measurements of the direction of drift and the apparent velocity of the several cloud-types were made at many stations, and measurements, by trigonometrical or other methods, of the height of these clouds above a few selected stations enabled the true velocity of the air-currents to be determined up to the altitude at which the cirrus clouds float. Thus an actual survey of the direction and speed of the atmospheric circulation at different levels was effected, and a recent discussion of the results by Professor Hildebrandsson shows that the theories which have been held heretofore are untenable. Professor Hildebrandsson's conclusions in brief are that there is no exchange of air between poles and equator, the circulation over the oceans, at least, resolving itself into four great whirls, the air which rises above the tropics flowing over the trades and descending probably in the extra-tropical regions, while around each pole is an independent cyclonic circulation. Although this general circulation of the atmosphere appears to be indicated, many details require to be investigated. In particular, the movements of the great masses of air overlying the trade winds and doldrums, which is a region nearly barren of clouds, are still unknown and the determination of these movements, as well as the temperature and humidity of the different strata, by means of kites flown from steamships, was suggested by the writer, since it would be possible in this way to penetrate even the masses of quiescent air which probably separate the trade winds from the superposed antitrades. This suggestion has already been put in practise on the yacht of the Prince of Monaco in the neighborhood of the Azores, but a more extensive campaign is necessary, which the writer himself hopes to undertake, if the funds necessary to charter and equip a steamer can be procured.

Here it will be encouraging to state some results of the efforts to ascertain the vertical thermal and hygrometric gradients in the atmospheric ocean, and to show what may be accomplished in the future. Observations on mountains, as we have seen, can not be expected to give the conditions which exist at the corresponding heights in the free air and hence the necessity of sending observers or self-recording instruments into this medium through the agency of balloons and kites. By the aid of an international committee formed eight years ago under the direction of Professor Hergesell at Strassburg, much has been accomplished in Europe in this way, and something in this country through kite-flights. At the present time such atmospheric soundings are made once a month in most European countries, and at Blue Hill in the United States, with the result that a knowledge is being acquired of the vertical gradients of the meteorological elements which entirely contradicts previous conceptions. For example, it was formerly supposed that the temperature diminished with increasing altitude more and more slowly and that at a height of about ten miles it remained invariable during winter and summer and above pole and equator. But the recent investigations of my colleagues in France and Germany show that the temperature

decreases faster and faster as one rises in the air and that not only is there a large seasonal variation at the greatest heights attained, but that non-periodic changes occur from day to day, as they do at the earth's surface. Still more remarkable is the indication of a warm current at a height of about seven miles, while the stratification of the atmosphere as regards temperature, moisture and wind has been shown by the kite-flights at Blue Hill to be a normal condition, and not merely confined to the high atmosphere as was formerly supposed. Daily soundings of the atmosphere to the height of a mile or two are now being made with kites and captive balloons at the meteorological institutes of Berlin, Hamburg and St. Petersburg, and are furnishing valuable data concerning the changes in the meteorological elements which occur simultaneously or successively in the overlying strata.

Of the various unsolved questions relating to this subject perhaps the most important is whether the core of the cyclone possesses the excess of temperature over the surrounding body of air which the convectional theory of its origin requires. We need to know also the height to which the cyclone extends, the circulation around it at various levels, and further to generalize the theory of an accompanying cold-center cyclone in the upper air, deduced by Mr. Clayton from the Blue Hill observations. Other vexed questions can be elucidated by similar researches, such as the conditions favorable for precipitation and the action of dust-nuclei in producing it, the source of our American cold-waves, the exact relations of thunderstorms and tornadoes to centers of pressure and temperature and, finally, the causes which, in the upper air, influence the trajectories and velocities of the cyclones and anti-cyclones that give us our broader weather features. When these correlations are determined from the investigations of the free air now in progress, and we possess a sufficient number of aerial stations to make it possible to chart a daily map of the upper air, then we may expect an improvement in the weather forecasts. The prediction of fog over the ocean on, and adjacent to, our coasts is of great practical importance to shipping, especially off the banks of Newfoundland, and the writer believes that meteorological kites flown from a steamer in these regions would reveal the unknown relations of temperature, humidity and wind in and above the fog-bank which might lead to the prediction of the conditions favorable to its formation.

We now pass to another branch of meteorological research, namely, the cosmical relations. It is incontestable that the sun, the source of all terrestrial energy, has great influence upon the magnetic conditions of the earth, but a consideration of the relation of terrestrial magnetism and meteorology will be left to my colleague, Dr. Bauer. The cause of atmospheric electricity has always been an enigma to meteorologists, but the discovery of 'ions,' or 'electrons,' as carriers of electricity, has thrown some light on this question. It is of importance in geophysics to know how the capacity of the air for positive and negative electrons varies with altitude, and also the periodic and non-periodic variation of the potential at the earth's surface.

Attempts to regard all atmospheric phenomena as periodic and due to the influence of the sun or moon have long occupied the attention of eminent investigators, but it must be admitted that the effects of neither the periods of solar nor those of lunar rotation upon the earth's meteorology can be claimed to have been proved, although a correspondence has been found by the distinguished speaker who preceded me in regard to the frequencies of auroras and

thunderstorms and the position of the moon in declination. To Professor Arrhenius is also due the remarkable generalization that the pressure of light emanating from the sun causes alike the streaming away from it of comets' tails, the zodiacal light and the aurora borealis. The relation of sunspot frequency, which has a periodicity of about eleven years, to atmospheric changes on the earth, especially as manifested by barometric pressure, rainfall and temperature in India, has been investigated, and the coincidences, even if nothing more, which have been shown to exist by Sir Norman Lockyer and his son are suggestive. It may be pointed out that the same action of the sun might cause simultaneously increased rainfall in India and a deficiency of rainfall in England, because rising currents in one region are necessarily accompanied by descending currents elsewhere, and, therefore, no objection can be offered to a theory of cosmical influence which produces different weather conditions in different parts of the globe.

Since the sun is the source of our energy, the discovery of any variation in the heat emitted is of the deepest interest and the important investigations of Professor Langley are now to be supplemented by the broader work of a committee appointed by the National Academy of Sciences and also by an international committee, with the general object of combining and discussing meteorological observations from the point of view of their relation to solar phenomena. It does not seem improbable, therefore, that eventually we may have seasonal predictions of weather, possessing at least the success of those now made daily, and that possibly forecasts of the weather will be hazarded several years in advance. The value of such forecasts, as affecting the crops alone, would be of inestimable benefit to mankind, and predictions already made in India for the ensuing season, while not entirely successful, have still proved advantageous. A number of short cycles in the weather have been detected, including a seven-day period in the temperature. which Mr. Clayton found could be used for forecasting were it not for an unexplained reversal in the phase of the temperature oscillation.

The interesting question of the value of meteorological observations may appropriately conclude this address. Professor Schuster, the English physicist, has recently denounced the practice of accumulating these observations with no specific purpose. To an extent this criticism is valid in all the sciences, since those observations are most useful when made by or for the person who is to utilize them, but although modern meteorology demands special series of observations to solve such problems as the temperature in cyclones and anticyclones, it is sometimes true that long series of observations made with one object in view may subsequently become valuable for quite another purpose. For the study of climate and its possible change, long-continued observations in each country are a necessity, though these might properly be confined to selected stations from whose normals the values for other stations may be computed. Professor Schuster's wish to limit the number of observations implies that the existing series have been inadequately discussed, for the reason that it is easier to find observers than competent investigators. For this unfortunate condition the weather services of most countries are chiefly to blame, because, being burdened with the routine work of collecting climatological and synoptic data and formulating and promulgating weather forecasts, which is the public estimate of their entire duty, most government meteorological organizations concentrate their energies and expenditures on these functions and par-

tially or completely neglect the researches by which alone our knowledge of the mechanics of the atmosphere can be increased. In this criticism must be included the United States Weather Bureau (exception being made in favor of Professor Bigelow's discussions), and the similar bureaus of such equally enlightened countries as France and England. However, in the latter country an attempt is now being made to create an Imperial meteorological institute which could undertake the discussion of the great mass of data accumulated in Great Britain and her colonies, especially the relations of solar phenomena to meteorology and magnetism, and it is argued that this would contribute towards the formation of a body of scientific investigators adequate to the needs of the British Empire and be of the highest educational and scientific worth. In the United States, meteorological research has always been fostered by individuals, of whom the names of Franklin, Redfield, Espy, Coffin, Maury, Loomis and Ferrel are brilliant examples. To-day my colleague, M. Teisserenc de Bort in France, and we ourselves at Blue Hill, are endeavoring, unassisted, to solve problems in dynamic meteorology, which ought to be undertaken by the national services of our respective countries. It behooves then those who are desirous of advancing the status of meteorology to strive to convince the public that the function of a government bureau is not merely to collect meteorological data and to make inductive weather predictions based on remembrance of the sequence in similar conditions, but that the science of meteorology requires laborious researches by competent men and the generous expenditure of money before practical benefit can result from improved weather forecasts. If some of my hearers are converted to such an opinion, this address will have served a useful purpose.

A. Lawrence Rotch.
Blue Hill Meteorological Observatory.

SCIENTIFIC BOOKS.

The Lymphatics. By Poirier, Cunéo and Delamere. Translated and edited by Cecil H. Leaf. Chicago, W. T. Keener & Co. 1904.

The chapters on the 'Lymphatic System' in Poirier's 'Anatomy' have been translated into English and presented in book form by C. H. Leaf. The first half of the book is on the 'General Anatomy of the Lymphatics,' and is by Delamere, while the second half is by Poirier and Cunéo and treats of the 'Special Study of the Lymphatics in Different Parts of the Body.' The translation is thoroughly well done.

The increasing interest in the lymphatic system makes the appearance of such a book especially welcome. It is the most complete and comprehensive monograph on the lymphatic system that we have and will fill a long-felt need. It contains some original work, especially the last half. The two parts are distinct and will be taken up separately.

The plan of the first part is excellent, the subject being treated systematically under four heads, the lymph, the leucocytes, the lymphatic vessels and the glands. Each subject is treated first practically, by giving our definite knowledge about it, and then theoretically. The practical part is excellent, clear, comprehensive, definite and not diffuse. It brings together facts for which one would otherwise have to hunt through many books. The treatment of the theoretical part, on the other hand, is weak. For example, under the lymph, its properties, physical and chemical, are unusually well given; but in the treatment of the theories of the formation of lymph it is not clearly brought out that there are two opposing theories; one that physical forces are sufficient to account for the formation of lymph, and the other that it is a secretion of endothelial cells. It is not shown that the physical theory, which has grown out of the

filtration theory of Claude Bernard, involves not only filtration, but osmosis and diffusion. The arguments for the secretion theory are more fully given, but not well analyzed. For example, Rauvier's observation that the large sacs, which are so characteristic of developing lymphatic capillaries, are filled with a fluid different from blood plasma is given as evidence that this fluid is the result of secretion, while as a matter of fact it is not an argument for one side more than the other.

The subject of the leucocytes is a difficult one to treat. The descriptions of the different types are excellent, much better than in the average text-book, and can not fail to be helpful to the student. Many special points, familiar to one with experience in blood work, but perplexing to the student, are brought out. For example, the difficulty of drawing a sharp line between the small and large mononuclears. The different solubilities of the granulations is another valuable point. The theory of phagocytosis is so identified with the name of Metchnikoff that one is surprised to find but a casual mention of his work in this connection. It also seems a mistake not to mention that in view of the studies on chemiotaxis and immunity our ideas of the physiology of the leucocytes now include much more than phagocytosis.

In regard to the granulations, our author asks of what is the physiological value of distinctions established by color reactions. This point is brought out in a more interesting and fruitful way by Ehrlich in his book on 'Die Anaemie,' when he says that only a part and, perhaps, only a small part, of our knowledge of leucocytes can come from histological studies, that we must turn to experimental work and to pathology for a wider knowledge. However, the classification given by our author is based on the granulations and we believe that it is the best classification that we have. No classification can be thoroughly rational until we know the origin of the leucocytes. The grouping given by Delamere is certainly practical. He divides the leucocytes into five classes: (1) microcytes (lymphocytes), (2) macrocytes (large mononuclears), (3) cells with neutrophilic granules (polymorphonuclears), (4) cells with acidophile granules (eosinophiles), (5) cells with metachromatic basophile granules (mastzellen). This is based as much as possible on the granulations, for the macrocyte has basophile granules and the microcyte is without granules. This classification is also best adapted to the study of bone marrow.

In regard to the theories of the formation of the leucocytes the treatment is again weak. The theory that the leucocytes come from the lymph nodes, and the granular forms from the bone marrow, is attributed to Denys. This theory our author brushes aside on the ground that the leucocytes are present before the bone marrow is formed. This is of course true, just as much as that lymphocytes occur in the thymus before lymph nodes are formed, and that blood cells occur in the blood islands of the area vasculosa entirely outside the body. This theory, as developed by the Ehrlich school, recognizes that there are many places for the development of blood cells in the embryo, but that in the adult the bone marrow gives rise to the granular forms. It can not be considered as proved, but it gives the most fruitful working bases we have at present. It has been built up through a study of the anæmias and leukæmias and it certainly can not be brushed aside without taking into consideration the pathological evidence. It leaves the question of the origin of blood cells from connective tissue open, stating that whether the leucocytes come from preexisting blood cells or from connective tissue cells they are formed in the adult in the lymph nodes and bone marrow. In regard to the origin of the leucocytes from connective tissue our author is dogmatic when he says that it is proved that a leucocyte can become a connective tissue cell, and it is at least very probable that a connective tissue cell can become a white cell. In reality we are waiting for a new way of attacking this problem.

The chapter on the lymphatic vessels is thoroughly interesting and much in advance of the usual text-book, since it is based on the work of Ranvier. It has, however, certain mistakes of Ranvier's. It is as clear a statement of the subject as could be given without

logues of Lagrange's equations, indispensable matrix of all mechanics.

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materials, methods, equipment and zoological books, these latter chapters having a direct positive practical character just such as the inquiring teacher must need. In the discussion of the relation of school courses in zoology to college entrance credits in that subject the author argues for an entrance option in zoology, which indeed is wise, since under educational conditions in this country it is well-nigh impossible to secure proper time and attention to a subject in the high school unless it can be counted for college entrance. The author makes the welcome announcement that such an option is being formulated by an authoritative committee, and is to be published, probably early in 1905. The final chapter deals with the teaching of human physiology in the high school, which the author thinks should be combined with the instruction in zoology. It is interesting to observe the temperate but firm stand the author takes upon a subject which scientific men can hardly be expected to speak of with patience —the 'scientific temperance' instruction in schools.

The limits of space forbid more than this inadequate account of the parts of this very sane, modern, scientific and quite admirable book. It is indispensable to the teacher of biology, and it will exert great influence upon future biological teaching. W. F. Ganong.

Outlines of Physiological Chemistry. By S. P. Beebe, Ph.D., and B. H. Buxton, M.D. New York, The Macmillan Company. 1904. $1.50.

The title of this work does not correctly describe its contents or define its scope. It contains little physiological chemistry in the ordinary sense of the term. Yet it may prove a very useful handbook as an outline of chemical theories for the use of physiological chemists.

There are many laboratory guides in physiological chemistry now available. These works, however, have in most cases given little space to the theoretical side of the subject. In order, therefore, to repair this deficiency the student must consult the hand-books of physical chemistry and of organic chemistry. In doing so he is apt to overlook those matters which especially concern him, because of the great mass of unfamiliar ideas with which he meets, and because the writers of such works had not his special needs in view. The work before us aims to meet these special needs. It presents in convenient form so much of chemical theory as is essential to the comprehension of the subject matter and present problems of physiological chemistry.

The first chapter (twenty pages) is devoted to that part of physical chemistry which is of especial importance in physiological chemistry—the theory of solution. It explains briefly and clearly the significance of dissociation, chemical equilibrium, osmotic pressure, why reactions take place, and calculation of chemical formulæ. The succeeding four chapters are devoted to organic chemistry. Structural formulæ of the paraffins, and of the nitrogen and cyclical compounds, are given quite fully, and their significance clearly set forth. In chapter VI. sixty pages are devoted to the proteids, their chemical character, in the light of the preceding chapters, being dwelt upon rather than their reactions as in a laboratory guide. Chapter VII., on enzymes, gives an account of this most important subject, which is not so well generalized as is the treatment of the subject matter of earlier chapters. It even encroaches on the domain of the laboratory guide in giving an enzymatic test for the detection of tyrosin. The eighth and final chapter presents diagrams of Ehrlich's side chain theory, and explains their significance for the phenomena of disease and immunity.

The usefulness of this book would have been enhanced by giving at the end of each chapter a list of the works to which the reader might refer for more detailed information.

The typographical work, which in the presentation of diagrams and structural formulæ is of prime importance, is excellent throughout.

Yandell Henderson.
Yale Medical School.

Scientific Journals and Articles.

The November Number of the *Journal of Nervous and Mental Disease* opens with an

address delivered at the thirtieth annual meeting of the American Neurological Association held at St. Louis, September 15, 1904, by the president, Dr. Frank R. Fry. Dr. Fry briefly reviewed the growth of neurology as a specialty, dwelling particularly on the part played by America in its later development, and summarizing the history of the organization. In an article on 'Purulent Myelitis, Focal and Disseminated,' Dr. Joseph Collins presents an interesting case of this uncommon disease illustrated by numerous cuts. In an elaborate discussion of 'Hallucinations' Dr. William A. White, after criticizing some current differential definitions of hallucinations and illusions, together with various theories explanatory of the latter, sets forth that arrived at by himself and Dr. Sidis, namely, the 'peripheral theory,' which refers the origin of hallucinations to a pathological process in the end organ. The proceedings of the Chicago Neurological Society for March 24, 1904, are reported in this number, and the 'Periscope' includes the usual abstracts of periodicals, *Archives de Neurologie, Journal de Neurologie, Allgemeine Zeitschrift für Psychiatrie, American Journal of Insanity, Neurologisches Centralblatt, Centralblatt für Nervenheilkunde und Psychiatrie,* and *Revue de Psychiatrie et de Psychologie ' Expérimentale.* 'Miscellany summarizes an article on 'Criminal Types,' by G. C. Speranza in *American Law Register,* for March, 1904. Two books, 'On the Moral Feeble-mindedness of Women,' by Katinka von Rosen, and 'Les Psychonevroses et Leur Traitement Moral,' by Dr. Dubois, are reviewed.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

THE American Association for the Advancement of Science, the American Society of Naturalists and the following societies will meet at Philadelphia, Pa., during the week beginning December 24, 1904:

The American Association for the Advancement of Science.—The week beginning on December 27, President, Professor W. G. Farlow; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, President Charles S. Howe, Case School, Cleveland, Ohio; secretary of the council, Professor Clarence A. Waldo, Purdue University, Lafayette, Ind.

Local Executive Committee.—President, Provost Charles C. Harrison; vice-president, Professor Edgar F. Smith; secretary, Dr. Philip P. Calvert; treasurer, Dr. Samuel G. Dixon; chairman of the executive committee, Provost Charles C. Harrison; of the committee on reception and entertainment, Mrs. Charles C. Harrison; of the committee on hotels and boarding houses, Professor Amos P. Brown; of the committee on meeting places and equipment, Professor Edwin G. Conklin; of the committee on press and printing, Mr. George E. Nitzsche; of the committee on transportation, Mr. Walter Wood; of the committee on finance, Mr. S. F. Houston.

Section A, Mathematics and Astronomy.—Vice-president, Professor Alexander Ziwet, University of Michigan; Secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Wm. F. Magie, Princeton University; Secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Leonard P. Kinnicutt, Polytechnic Institute, Worcester, Mass.; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor David S. Jacobus, Stevens Institute, Hoboken, N. J.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Eugene A. Smith, University of Alabama; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. J.

Section F, Zoology.—Vice-president, Dr. C. Hart Merriam, U. S. Dept. of Agriculture; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Professor B. L. Robinson, Harvard University; Secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. Walter Hough, U. S. National Museum; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Vice-president Martin A. Knapp, U. S. Interstate

Commerce Commission, Washington; Secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor H. P. Bowditch, Harvard University.

The American Society of Naturalists.—December 27, 28. President, Professor E. L. Mark, Harvard University; secretary, Dr. Chas. B. Davenport, Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y.

The Astronomical and Astrophysical Society of America.—December 28, 29. President, Professor Simon Newcomb; secretary Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 30. President, Professor Arthur G. Webster; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 28–31. President, Professor Arthur A. Noyes, Massachusetts Institute of Technology; secretary. Professor William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 29–31. President, Professor J. C. Branner, Stanford University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Botanical Society of America.—December 27–31. President, F. V. Coville; secretary, Dr. D. T. MacDougall, N. Y. Botanical Garden, Bronx Park, New York City.

The Society for Plant Morphology and Physiology.—December 28, 29, 30. President, Dr. G. T. Moore, Department of Agriculture, Washington; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

The Botanical Club of the Association.

The Fern Chapter.

Sullivant Moss Chapter.

Wild Flower Preservation Society of America.

The Society for Horticultural Science.—President, Professor L. H. Bailey, Cornell University; secretary, S. A. Beach, Geneva, N. Y.

The Society for the Promotion of Agricultural Science.—December 26. Secretary, Professor F. M. Webster, University of Illinois, Urbana, Ill.

The Association of Plant and Animal Breeders.

The Association of Economic Entomologists.—President, Professor A. L. Quaintance, Washington, D. C.; secretary, Professor H. E. Summers, Ames, Iowa.

The Entomological Club of the Association.

The American Society of Zoologists (Eastern Branch).—December 27, 28. President, Professor E. A. Andrews, Johns Hopkins University; secretary, Professor Gilman A. Drew, University of Maine.

The American Society of Vertebrate Paleontologists.—December 28–30. President, Professor H. F. Osborn, Columbia University; secretary, Dr. O. P. Hay, American Museum of Natural History, New York City.

The Society of American Bacteriologists.—President, Professor F. G. Novy, University of Michigan; secretary, Professor F. P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December 27, 28. President, Professor R. H. Chittenden, Yale University; secretary, Professor Lafayette B. Mendel, New Haven, Conn.

The Association of American Anatomists.—December 26, 27, 28. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

American Folk-Lore Society.

The American Anthropological Association.—December 27–Jan. 2. President, Dr. W J McGee, Washington; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Psychological Association.—December 28, 29. President, Professor William James, Harvard University; secretary, Professor Livingston Farrand, Columbia University, New York City.

The American Philosophical Association.—December 28, 29, 30. President, Professor George T. Ladd, Yale University; secretary, Professor H. N. Gardiner, Northampton, Mass.

The Sigma Xi Honorary Scientific Society.—President, Professor S. W. Williston, University of Chicago; secretary, Professor Edwin S. Crawley, University of Pennsylvania, Philadelphia, Pa.

THE OHIO ACADEMY OF SCIENCE.

The fourteenth annual meeting of the academy was held in Cleveland at Adelbert College on November 25–26. The program was somewhat shorter than for preceding meetings but was unusually interesting, especially the longer papers of the first half day's session. The address of the retiring president, E. L. Moseley, was one of the best ever presented to the academy. In it he traced the formation of Sandusky Bay and gave detailed evidences of the growth of Cedar Point. The paper by Professor George Bruce Halsted on

'Mathematics and Biology' was of especial interest at this time on account of its bearing upon the principle of variation and mutation.

The recently adopted rule of not allowing papers to go on the program unless an abstract had been handed in by the author was adhered to by the program committee. This committee was enlarged for the coming year so as to have five members, one for zoology, one for botany, one for geology and physiography, one for archeology, anthropology and ethnology, and one for mathematics, chemistry and physics.

The next annual meeting will be held at the University of Cincinnati during the Thanksgiving recess, 1905. The following officers were elected:

President—Herbert Osborn, Columbus.

First Vice-President—C. W. Dabney, Cincinnati.

Second Vice-President—F. M. Comstock, Cleveland.

Secretary—L. B. Walton, Gambier.

Treasurer—J. S. Hine, Columbus.

Member Board of Trustees—C. J. Herrick, Granville.

Elective Members Executive Committee—S. H. Williams, Oxford, and F. C. Waite, Cleveland.

The annual contribution of $250 to the research fund of the society was again furnished by Emerson McMillin. The following papers were read:

E. L. MOSELEY, Sandusky High School: President's address, 'The Formation of Sandusky Bay and Cedar Point.'

PROFESSOR GEORGE B. HALSTED, Kenyon College: 'Mathematics and Biology.'

PROFESSOR D. C. MILLER, Case School of Applied Science: 'Radium' (illustrated).

PROFESSOR FRANCIS H. HERRICK, Western Reserve University: 'The Building Habits and Home Life of Birds' (illustrated from original photographs).

A. A. WRIGHT, Oberlin College: 'Episodes in the Development of Rocky River.'

JAMES S. HINE, Ohio State University: 'Some Ohio Mammals.'

A. A. WRIGHT: 'Our Smallest Carnivore (*Putorius Allegheniensis*),' with exhibition of specimen.

JOSUA LINDAHL, Cincinnati: 'A List of Isopoda from Ohio.'

HERBERT OSBORN, Ohio State University: 'Report of Progress in the Study of the Hemiptera of the State.'

L. B. WALTON, Kenyon College: 'A Land Planarian in Ohio.'

MISS LUMINA C. RIDDLE: 'The Protozoa of Brush Lake.'

L. B. WALTON: '*Actinolophus minutus*, a New Heliozoan, with a Review of the Species Enumerated in the Genus.'

F. L. LANDACRE, Ohio State University: 'Report of Progress on the Survey of the Protozoa of Sandusky Bay and Vicinity.'

F. L. LANDACRE: 'Note on the Rate of Growth in Stalked Infusoria.'

F. L. LANDACRE,
Retiring Secretary.

THE SCIENCE CLUB OF NORTHWESTERN UNIVERSITY.

THE Science Club of Northwestern University held its regular monthly meeting December 2.

Professor A. V. E. Young, of the department of chemistry, gave a paper on 'Mendeleef's Conception of the Ether.' Mr. J. N. Pearce, of the same department, discussed 'Colloidal Metal Solutions.' Both papers were followed by a general discussion. FLOYD FIELD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

CONVOCATION WEEK.

IN the earlier years of the American Association it had at least four important functions: (1) It gave opportunity for expert scientific discussion. (2) It fostered the scientific spirit and developed scientific interest in the people of the land (*a*) by admitting non-expert as well as expert membership, thus giving an opportunity for non-expert discussion, (*b*) by assembling popular or semi-scientific audiences, (*c*) by a peripatetic system of meetings in which few places were visited more than once. (3) It promoted the solidarity of the scientific body by affording opportunity for personal acquaintance and intercourse (*a*) of students of the same subject, (*b*) of students of different subjects. (4) It undertook the

discussion of general subjects affecting the welfare and interests of the scientific body.

With the growth of the scientific body the experts eventually found their discussions hampered by various conditions growing out of non-expert membership, and special societies were organized. These societies have to a great extent assumed the first of the functions enumerated above, but they ignore the second. Their tendency is toward solidarity of special groups of scientists (3*a*) but against solidarity of the general body (3*b*). They can not perform the fourth function without federation. In the reorganization now in progress the association is becoming the means of federation, the integrating factor; and this relation may be called its fifth function.

The special societies have found, and in the main may be expected to find, the winter more convenient than the summer for their principal meetings. They tend to monopolize convocation week, and by holding the attention of the body of experts interfere, at that time, with the success of the sectional sessions of the association. In view of these and other considerations, it seems to me desirable that the association hold two annual meetings. At a winter meeting, held in conjunction with the affiliated societies, it should function chiefly as the bond of union and the conservator of common interests; its proceedings should include general business, a presidential address and a popular lecture, a few selected papers, or a prearranged discussion on a topic of general interest; and there should be no division into sections. A summer meeting, having for a leading purpose the diffusion of scientific interest, should include the work of sections, popular lectures and excursions.

Under such an arrangement it is not to be supposed that the attendance at the two meetings would be constituted in the same way. The differentiation of work, being an adjustment to the diversity of tastes and needs in the membership, would naturally result in a partial differentiation of personnel. Such a separation is not on all accounts desirable, but it seems to me better than the relinquishment of either of those important functions of the association for which the encroaching special societies fail to make provision.

G. K. Gilbert.

Washington, D. C.,
December 7, 1904.

The Term 'Geology.'

To the Editor of Science: May I trespass once more upon your valuable space to reply to Dr. C. R. Eastman's note in your last number (Science, No. 517), in which he claims to have finally proved me inaccurate in giving credit to De Saussure as the first geologist who used the term 'geology' in the modern acceptation of the word.

While Dr. Eastman and I are quite agreed as to the importance of more care among scientific writers in the citation of ancient authorities, there seems to be this essential difference in our methods. That he is a strict constructionist and clings to the very letter of the law, while I consider it more important to get at the true spirit of the citations, thinking thus to trace more correctly the progress of human thought—a difference which the present case seems to me to well illustrate.

It will be noted that I said De Saussure *appears* to have been the first to use the term geology in writing on his science.

In his 'Lettres Physiques et Morales sur les Montagnes,' published in 1778–9, De Luc, to whom Von Zittel gives priority over De Saussure, uses the term cosmology for the science that treats of the knowledge of the earth, although he says in his preface (page viii) that the proper word would have been geology, but that he 'could not venture to adopt it because it was not a word in use.' De Saussure, on the other hand, writing on the Alps in 1779, employs the term geology without any explanation or apology and alludes to the geologist as if he were a very well-known species of natural philosopher.

In the extremely condensed form in which I was obliged to treat my subject to bring it within the limits of a presidential address, it seemed inadvisable to introduce such explanations as this, hence my use of the word *appears*, implying the possibility of another construction of the statement.

As to the earlier uses of the word given in Murray's 'New English Dictionary,' which, in Dr. Eastman's opinion, furnish a further proof of my want of accuracy, I regard them as proving quite the contrary, as is shown in the following brief analysis of the references under geology.

Richard de Bury's use of the word is defined as 'applied to the study of the law as distinguished from the arts and sciences, which are concerned with the works of God.'

'Geologia' is also the title of an Italian work by F. Sessa, which is intended to prove that the influences ascribed by astrologers to the stars really proceeded from the earth itself. As Murray evidently recognizes, neither of these usages has any relation to modern geology.

He subdivides the later usages of the word geology as (1) 'The science which treats of the earth in general.'

Of those referred to as having used it in this sense, Erasmus Warren (1690) was a Suffolk rector, defending the literal correctness of the Mosaic account of the deluge; B. Martin (1735), a learned optician, who classified rather elaborately the science of his day; and Nathan Bailey (1736) and Dr. Samuel Johnson (1755), lexicographers, who defined it as 'the doctrine of the earth.'

None of these, it is evident, could be considered to be geologists.

It is only Murray's second division—namely, 'the science which has for its object the investigation of the earth's crust, etc.,' which corresponds to the modern acceptation of the word considered in my address, and under this head his first reference is to J. Hutton (1795), who published sixteen years after De Saussure.

Hence, in spite of Dr. Eastman's specious representation of the facts, only a moment's consideration of which he thinks necessary to prove my historical inaccuracy, I still maintain the correctness of my statement, in which I have followed so excellent an authority as Sir Archibald Geikie, who says, in his chapter on De Saussure ('Founders of Geology,' page 88), 'the earliest writer who dignified it [geology] with the name it now bears, was the first great explorer of the Alps.'

S. F. EMMONS.

WASHINGTON,
November 28, 1904.

THE KELEP AND THE COTTON PLANT.

TO THE EDITOR OF SCIENCE: Professor Wheeler's criticism of Dr. Cook's theory regarding the association of the kelep or Gautemalan ant, with the cotton for its nectar (SCIENCE, December 2, page 768) is quite timely. Dr. Cook's theory and the facts upon which it is founded are decidedly unique. In bulletin 49, Division of Entomology, U. S. Dept. of Agriculture, page 64, Professor Cook states that in Texas 'More ants will be necessary, however, for their protection, and the nectar-producing qualities of the different varieties may become a question of practical importance if the kelep should become established.' "At present the nectar secreted on the leaves and squares of the cotton goes to waste, or even serves to attract injurious insects, among them the boll worm moths."

"The discovery of the ant supplies a practical reason for the existence of the nectaries hitherto quite unsuspected, and it suggests the further possibility that the weevil and the ant may have been factors in the evolution of the cotton plant, for the weevil is not known to feed on any plant except cotton." Was the kelep then first attracted to the cotton on account of the nectar or by its appetite for the weevil? That the nectar of the cotton otherwise goes to waste is a surprising statement, inasmuch as a very large proportion of the honey stored by honey bees throughout the southern states is secured from cotton, as is well known to all practical bee keepers. Furthermore, the writer was under the impression that American cotton was originally of oriental origin. If so, how could the kelep and boll weevil have been a factor in the evolution of the cotton plant in the orient where they are not known to occur?

It would seem to the writer that considerably more evidence is necessary to establish such a theory, and that a more intimate knowledge of the cotton plant and the insects

associated with it is highly desirable before it can be stated that nectar at present 'goes to waste.'

E. Dwight Sanderson.
New Hampshire College,
Durham, N. H.,
December 6, 1904.

ANENT GIZZARDS.

Professor Eastman* expresses his willingness 'to consign to birds the exclusive enjoyment of gizzards and feathers'; but this seems hardly fair to certain fishes. According to Günther† in the well-known gray mullets (*Mugil*) "the second portion of the stomach reminds one of the stomach of birds; it * * * is globular, and surrounded by an exceedingly strong muscle. This muscle is not divided into two as in birds, but [is] of great thickness in the whole circumference of the stomach, all the muscular fasciculi being circularly arranged. The internal cavity of this stomach is rather small, and coated with a tough epithelium * * *. A low circular valve forms a pylorus." Certainly one can not carp at Drs. Jordan and Evermann‡ for referring to this apparatus as 'gizzard-like,' with which adjective Mr. Barnum Brown contented himself when writing of the plesiosaurs.

The food of the mullets is said§ to consist 'chiefly of the organic substances mixed with mud or sand,' of which they 'take in a quantity.' However, it must also be set down that 'in order to prevent larger bodies from passing into the stomach * * * these fishes have the organs of the pharynx modified into a filtering apparatus' so that 'stomach stones' if present, can never be large. At all events (to state the obvious conclusion) if two such widely separated vertebrates as *Gallus* and *Mugil* have independently evolved gizzard-like modifications of the stomach, why should a similar possibility be denied *à priori* to all reptiles? But whether plesiosaurs were 'lithophagi' or lotus eaters Herodotus saith not.

W. K. Gregory.
American Museum of Natural History.

* Science, N. S., Vol. XX., October 7, 1904, p. 466.

† 'An Introduction to the Study of Fishes,' p. 503.

‡ 'The Fishes of North and Middle America,' Part I., p. 809.

§ Günther, *op. cit.*, p. 502.

NOTE ON THREE VERY LARGE BEAKED WHALES FROM THE NORTH PACIFIC.

To the Editor of Science: Early in November last, I received a letter from President D. S. Jordan, of the Leland Stanford, Jr., University, enclosing a communication from Mr. J. H. Ring, of Ferndale, Humboldt County, California, relative to the stranding of a whale about forty-one feet long near that place. Mr. Ring's letter was accompanied by photographs which made it evident that the animal was one of the ziphioid or beaked whales, of extraordinary size and not in a very good state of preservation. I have recently received additional information from Mr. Ring which makes it certain that the whale belongs to the genus *Berardius*. This genus was first recognized as belonging to the fauna of the North Pacific by Dr. Stejneger, who found a skull on Bering Island in 1882, and, believing it to represent a new species, gave it the name of *Berardius bairdii*. Whether the Ferndale specimen is of that species can not be determined until the skull has been examined.

The specimen is notable as being, so far as I am aware, the first of the genus reported from the Pacific coast of the United States, and further as being the largest beaked whale of which there is any record. In Mr. Ring's second letter, he informed me that he had remeasured the whale and found it to be 43½ feet long. The largest *Berardius* previously known was the type of *B. arnuxii* of New Zealand, which was 32 feet long.

Two large beaked whales were found on the coast of St. George Island, Pribilof Group, Alaska, in June, 1903, by Mr. James Judge, the resident treasury agent. One of these, a female, was reported by Mr. Judge as being 40 feet 2 inches long, and hence only a little smaller than the Ferndale whale. The other specimen, a male, was 25 feet 5 inches long. It is not certain that these Pribilof whales are of the genus *Berardius*, though the in-

formation thus far received points strongly to that conclusion.

The skeletons of these three whales have been secured for the National Museum, and it is my purpose to publish something more in detail regarding them at a later date.

F. W. TRUE.

U. S. NATIONAL MUSEUM,
December 8, 1904.

THE VASCULAR BUNDLES IN AN APPLE.

IT is probably a matter of little significance or importance as to just how many vascular bundles may be found about the core of an apple or how they are distributed. I have seen quite a number of cuts in books and bulletins, but I have never seen one that was right. Any person can soon decide this matter to his own satisfaction, by cutting transverse sections of several varieties of apples and allowing them to begin drying for a few days, when the bundles may be seen sticking out prominently.

W. J. BEAL.

A GEOGRAPHIC DICTIONARY.

IN SCIENCE, November 11, 1904, p. 649, Mr. Cleveland Abbe, Jr., states that he is compiling a dictionary of topographic terms. It may, therefore, be well to draw the attention of him and your other readers to a 'Glossary of geographical and topographical terms and of words of frequent occurrence in the composition of such terms and of place-names, by Alexander Knox, B.A., F.R.G.S., * * * London: Edward Stanford, 12, 13 and 14 Long Acre, W. C., 1904,' price 12*s* 6*d* ($3), being a supplementary volume to 'Stanford's Compendium of Geography and Travel.' This work appears richer in ordinary geographic terms and components of place-names than in technical physiographic terms, and no references are given to literature.

F. A. BATHER.

SPECIAL ARTICLES.

ASTER FORMATION IN ENUCLEATED EGG-FRAGMENTS OF CEREBRATULUS.*

MANY cytologists have accepted the view that the centriole (or centrosome) is a permanent and autonomous organ of the cell, but the direct proof or disproof of this hypothesis is very difficult, owing to the extreme minuteness of the centriole. The attempt to obtain decisive experimental evidence was first made (1901) by E. B. Wilson by shaking unfertilized eggs to pieces and subjecting the fragments to a salt solution. Asters capable of division, containing centrioles, appeared in a large number of the egg-fragments, including both those with and those without a nucleus. It is evidently highly improbable that all these centrioles can be considered as the offspring of preexisting ones, since it is an essential part of the centrosome hypothesis that the organ is primarily single, save when precociously divided into two. Wilson, therefore, came to the conclusion that some, at least, of the centrioles that appeared in such fragments must have been formed *de novo*. This conclusion has since been accepted by some writers, but attacked by others, partly on critical grounds, partly as a result of subsequent experiments in the same direction. A source of error in the experiment undoubtedly existed in the shaking of the eggs to pieces at random. Professor Wilson, therefore, suggested to me nearly two years ago to perform the crucial experiments of cutting the living eggs into two singly and treating the fragments individually. For this purpose the egg of *Cerebratulus* is particularly favorable, since before fertilization the first maturation mitotic figure lies at one pole, where it is seen very definitely in the living object as a clear space. By cutting off this part of the egg, one may be certain that the remaining portion contains no centrioles and, if centrioles appear in this portion of the egg, they must have been formed *de novo*.

I tried this experiment during the summers of 1903 and 1904, with results which are, I believe, decisive. The mode of operation was as follows: all the instruments and the female worm, from which the eggs were taken, were first thoroughly sterilized with fresh water so

* Abstract of a paper read before the meeting of the National Academy of Science, November 15, 1904. In this communication the term 'centriole' is used as equivalent to 'centrosome' in the original sense, *i. e.*, as the dividing and frequently persistent body at the center of the aster.

as to remove all danger of accidental fertilization. The eggs were then allowed to lie in sterilized sea-water for an hour and a half, during which time they showed no sign of having been fertilized. Individual eggs were then cut horizontally, one by one, into an upper nucleated fragment containing the maturation figure, and hence the two centrosomes, and a lower non-nucleated fragment. The latter was subjected to a solution of calcium chloride in sterilized sea-water. After an hour they were replaced in ordinary sterilized sea-water. As a result of this experiment, many, indeed almost all of the non-nucleated fragments produced asters, sometimes single, sometimes in large numbers (in one case more than a score of asters were observed in a single fragment). Many, practically all, asters contained centrioles. No cytasters developed in the control eggs allowed to remain in sterilized sea-water. Sections of the non-nucleated fragments thus treated showed that the asters and centrioles are identical in structure with those of an entire egg subjected to a solution of calcium chloride, while preparations of the corresponding nucleated half demonstrated the presence of the two original centrosomes. No other conclusion, therefore, is possible than that the centrioles of the non-nucleated half have been formed *de novo*. The experiment, I think, verifies the conclusion reached in Wilson's experiment, and is contrary to the negative result recently published by Petrunkewitsch. A detailed presentation of the evidence will be given hereafter.

N. Yatsu.

EARLIEST NOTICE OF AMERICAN PROBOSCIDEA.

The opinion is current and appears to be well founded that vertebrate paleontology in this country had its beginning in Thomas Jefferson's description of 'mammoth' remains from Virginia in 1787,* and of the bones of Megalonyx a dozen years later.

So far as scientific investigation goes, this is undoubtedly true, yet it is interesting to recall that fossil elephant remains have been known from the western world for a much longer period, and from Europe (Sicily) since at least the days of Empedocles of Agrigentum.

Not only was Columbus particularly enjoined by the Spanish sovereigns to bring back with him from America all manner of natural products, but in later years Hernandez, private physician to Philip II., and other distinguished functionaries were sent to Mexico for the special purpose of reporting upon the vegetable and zoological curiosities of the country. It was by these travelers, amongst the most prominent of whom besides the afore-mentioned were Oviedo, Acosta and Garcilaso, that fossil proboscidean remains were collected on the elevated plateaux of Mexico, Peru and elsewhere.

Detailed references are given in the second volumes respectively of Cuvier's 'Ossemens Fossiles' and Humboldt's 'Cosmos' to various old Spanish works in which these fossils were described as belonging to a race of human giants, the localities furnishing them being called '*Campos de Gigantes.*' The absurd discussions of '*Teutobochus rex*' in the early part of the seventeenth century are of interest only for revealing the crude state of natural science at that period. C. R. E.

*'Notes on the State of Virginia' (London, 1787).

CURRENT NOTES ON METEOROLOGY.

TEMPERATURE IN CYCLONES AND ANTICYCLONES.

At the 1904 meeting of the British Association, Mr. A. Lawrence Rotch summarized the results of observations obtained at Blue Hill Observatory during 34 kite flights, at different seasons, in areas of high and low pressure, up to about 12,000 feet. The mean decrease of temperature, computed by stages of 1,600 feet, is nearly constant, averaging 1° F. in 376 feet of ascent. Whether the whole column of air in a cyclone is warmer than the corresponding air in an anticyclone (as the convectional theory requires) depends chiefly upon whether its initial temperature at the ground is higher than that of the anticyclone, which is usually the case. If the data obtained from kite flights on consecutive days be plotted for the same height, as was first done at Blue Hill in 1899, it is seen that up to the height of 12,000 feet it is generally warmer at all levels over

areas of low barometric pressure than it is over the adjacent areas of high pressure. Kite flights on Blue Hill are now usually made once a month—upon the day fixed by the International Committee for Scientific Aeronautics.

CYCLONIC DISTRIBUTION OF RAINFALL.

Too much attention has always been paid to the annual, monthly and daily rainfalls, while far too little study has been made of the distribution of rainfall in individual cyclones. Cyclones are not regular in their occurrence, that is true, but they are our great rain-producers and from that point of view they deserve more attention. An important paper by Dr. H. R. Mill, 'On the Unsymmetrical Distribution of Rainfall about the Path of a Barometric Depression,' read before the British Association last August, deserves special mention as an investigation of a kind of which we have far too few. Ten instances of severe and widespread cyclonic rains have been investigated by Dr. Mill, and maps have been drawn showing the amounts of rainfall in each case, and the paths of the depression which brought the rain. It is found that the belt of cyclonic rains is much wider on the left of the path than on the right, and the heaviest falls occur in advance of the center. One of the most remarkable facts discovered is that the widespread cyclonic rains appear to bear no relation to the physical features of the country (*Symon's Met. Mag.*, October, 1904).

MORE LIGHT ON ANTARCTIC METEOROLOGY.

METEOROLOGY is coming to the aid of the geography of the lands in rather an interesting way in the Antarctic. To the *Geographical Journal* for August, Dr. Drygalski, leader of the German Antarctic Expedition, contributes a paper on some of the notable results obtained by the expedition. Dr. Drygalski believes that the new land discovered by the *Gauss*—Kaiser Wilhelm II. Land—is a part of the Antarctic continent, basing his opinion largely upon the meteorological conditions, especially the frequency and uniformity of the easterly gales. These gales have a *fœhn*-like character, and sweep down from the south over the vast, uniform, and but slightly inclined surface of the inland ice. The gales raged through nearly all of May and August, and were numerous in April and September. They even occurred in midsummer, but while they sometimes lasted from three to five days in winter, they only lasted for a day or two in summer. These storms were always accompanied by a heavy snowfall, and were a great obstacle in the way of scientific work.

THE PHYSICS OF THE FREE AIR.

UNDER the general supervision of Drs. Assmann and Hergesell, a new publication has been issued under the title, 'Beiträge zur Physik der freien Atmosphäre,' which is to be devoted to a discussion of the results obtained by means of balloons and kites. Mention has so often been made in these columns of the importance of the meteorological observations made in the free air during the last few years that there is no need of emphasizing the matter further at present. That there should be a field for an independent journal devoted solely to balloon and kite meteorology is very significant. There is a strong corps of associate editors, including Messrs. Rotch and Clayton, of Blue Hill Observatory, who have done so much work in 'sounding the ocean of air' in this country. In the same list we note also the following: Hann, von Bezold, Hildebrandsson, Pernter, Sprung, Abbe, Köppen, Shaw and others. The first number appeared in August, 1904, and is a quarto of 54 pages. The price per volume is 15 Marks.

NOTE.

IT is announced that the arrangement and discussion of the meteorological records obtained by Dr. Sven Hedin during his travels in Central Asia have been intrusted to Dr. Nils Ekholm, of Stockholm. The observations are to be ready for publication at the end of this year; the discussion is expected to appear next spring. R. DEC. WARD.

THE ISAAC NEWTON STUDENTSHIPS AT CAMBRIDGE.

PROFESSOR G. H. DARWIN writes as follows to the editor of the London *Times:* In 1891

the late Mr. Frank McClean, F.R.S., offered a large sum of money to the University of Cambridge for the foundation of three studentships, to be named after Sir Isaac Newton, for the promotion of the study of astronomy amongst our younger graduates. By the regulations adopted on the acceptance of this large benefaction by the university, the candidates must be under 25 years of age, and the student chosen at each annual election holds his studentship for three years. The income of the fund now amounts to close on £750, so that the stipend payable to each student suffices for his support. Since the object of the endowment was the promotion of scientific research, the students are prohibited from taking any other paid employment; and a succession of young men have thus been enabled to devote three of the best years of their lives to the untrammelled pursuit of science.

The recent death of Mr. McClean has naturally led us at Cambridge to review the effects which have resulted from his generous gift. The records of the electors to the Isaac Newton studentships, of whom I am the secretary, have fully confirmed the prevision of the founder as to the value of such an endowment of research; for we find on the list of past students the names of Professor Sampson, the editor of Adams's papers and director of Durham Observatory, of Mr. Dyson and Mr. Cowell, chief assistants at Greenwich Observatory, and of Mr. Hough, the chief assistant of the observatory at Cape Town. There are besides other past students who have already made their mark in those branches of physics and astronomy which fall within the scope of the endowment.

Mr. McClean was himself fully competent to estimate the effect of his own foundation, for he had attained to the high distinction of the award of the gold medal of the Royal Astronomical Society, which is open to the astronomers of all nations.

The large benefaction of which I have spoken is, however, by no means all that Mr. McClean has done for Cambridge and for other places. Only last year an anonymous donor, whom we now know to have been Mr. McClean, gave a considerable sum for the augmentation, during a period of five years of the stipends of two of the most distinguished of our mathematical lecturers. The foundation of the Stokes and Cayley lectureships, by means of this gift, practically makes a substantial, although temporary, augmentation of the mathematical professoriate of the University. I know from the men who have been nominated to these posts how great is the boon conferred on them, since they now have that leisure for which they had previously longed to devote themselves to science. We hope that the example thus afforded may induce other donors to make this endowment a permanent one.

Mr. McClean had, as the guest of Sir David Gill at the Cape of Good Hope, devoted himself to making a spectroscopic catalogue of southern stars, and he marked his visit to the Cape by presenting a fine telescope to that observatory.

Finally, since his death we learn that he has left a large bequest to the University of Cambridge for the adequate equipment of our observatory with spectroscopic appliances, and further that he has bequeathed to the Fitzwilliam Museum his valuable illuminated manuscripts and printed books, the collection of which formed the amusement of his leisure hours.

We residents at the university think we owe it to the memory of our benefactor to acknowledge the great value which we attach to all that this loyal son of Cambridge has done for us, and, at the same time, to record our sense of the great loss suffered by science and the university by his death.

Such magnificent and wise generosity has unfortunately been but too rare in this country. Is it too much to hope that this example may be followed by others whose wealth enables them to do inestimable service to science and letters by enlightened benefactions?

THE ROYAL SOCIETY.

The Royal Society held its annual meeting on November 30.

The report of the council as summarized in the London *Times* stated that one of the chief

events of the year had been the second general assembly of the International Association of Academies, which was held at Whitsuntide in the rooms of the Royal Society, directing academy of the association for the past three years. The general assembly was attended by seventy delegates, representative of all the constituent academies of the association. The proceedings were reported at the time in these columns, and it will be remembered that Vienna was chosen by a unanimous vote as the place of meeting of the next general assembly. The next subject was the geodetic survey now in progress in South Africa under the control of Sir David Gill. The subject of the extension of the arc beyond the Zambesi was brought up, at the instance of the Royal Society, at the recent meeting of the association in London, and it was hoped to secure the cooperation of the Egyptian government and that the Imperial German government might consent to become responsible for the portion of the arc which would traverse German East Africa. The Russian representative at the International Association expressed the hope that the arc would be ultimately connected through Syria with the Russian network, and thus extend continuously to Lapland; and, in consequence, it was resolved that diplomatic action be taken with a view to the extension of Struve's arc to Egypt. Dr. W. N. Shaw, F.R.S., attended the congress of the International Scientific Commission of Aerostation. The president and council had accepted the permanent duty of nomination to two posts in the supplementary laboratory and hostel which had been established at Col d'Olen, through the agency of Professor Mosso, as an adjunct to the existing International Laboratory of Physiology near the summit of Monte Rosa, and Dr. Ludwig Mond, F.R.S., had given £400 towards the expense of establishing the laboratory. The Royal Society Catalogue of Scientific Papers was in progress, and the last instalment extended from 1884 to 1900. The whole of the second annual issue of the International Catalogue of Scientific Literature had been published, with the exception of the volumes of Botany and Zoology, which were now being printed. The financial support given by the different countries was shown in detail, the total amounting to £6,755. With respect to the government grant for scientific investigations, the treasury had approved the addition of the following clause to the regulations for administering the government grant: "The president and council of the Royal Society may in each year set aside out of the reserve fund such sum as they may consider desirable to provide for any expenditure which may be incurred by the Royal Society (including expenditure on printing, clerks' salaries and office expenses) in undertaking, controlling, supervising or advising upon matters which the president and council may, at the request of the government, undertake, control, supervise or advise upon." Under the regulations the council had, on the recommendation of the Government Grant Committee, made grants this year amounting to £3,194 10s. This amount includes a preliminary grant of £500 to the joint permanent eclipse committee to cover the expense of instruments and preparations for observations of the total solar eclipse of 1905. A sum of £500 had been placed at the disposal of the president and council to meet any pressing demands upon the funds which might be made before the next annual meeting of the government grant committee. The investigation of sleeping sickness in Uganda was continued, after Colonel Bruce's return to England, by Dr. Nabarro and Captain Greig, of the Indian Medical Service. The efforts of the observers were now being directed to the attempt to discover a means of eliminating the trypanosomes from the blood and tissues of the infected in the early stages. In the meantime the Royal Society committee had advised the government to adopt such preventive measures as were found practicable for protecting a non-infected area where the carrier fly was found from the incursion of emigrants from the infected areas. There was next given in the report an account of the *Discovery* Antarctic Expedition, of which the scientific results were now being dealt with in accordance with the scheme agreed upon between the Royal and the Royal Geographical Societies. The two special expert committees were work-

ing as far as possible in concert with the authorities engaged in the reduction of the observations of the German and Scottish Antarctic Expeditions, which in part covered the same period of time. It was proposed that the special scientific results of the expedition should be published in a uniform series of volumes similar to the published records of the *Challenger* Expedition. The subject of Mediterranean fever was referred to the tropical disease committee of the society. At the request of the Colonial Office an advisory board was constituted as a sub-committee of the tropical diseases committee, with Colonel Bruce, F.R.S., as chairman. The president and council had received from the Court of the Goldsmiths' Company a grant of £1,000 'for the purpose of aiding the prosecution of original research work in connection with the character and properties of radium,' accepting the responsibility of the proper application of the grant. In December, 1902, the Lords of the Treasury appointed a committee, under the chairmanship of Sir Herbert Maxwell, F.R.S., M.P., to inquire into and report upon the administration of the parliamentary grant by the Meteorological Council, and to make such recommendations as might seem to them to increase the utility of the grant. The committee reported last May and commented forcibly on the insufficiency of the funds remaining over for progressive meteorological research. They advised that the service should be attached to one of the great government departments, in which case the present council would not be required. They pointed out how savings to the amount of £2,500 a year might be effected. The National Physical Laboratory had continued its work with success during the year, the last of the five for which the original annual grant of £4,000 was made by the Treasury. A memorandum had been sent to the Treasury which recommended (1) that a sum of nearly £30,000 was required for capital expenditure, and (2) that the annual grant should be raised in the course of four years to £10,000; while, with a view to supporting these proposals, a request was made for an official inquiry into the work and organization of the laboratory. The question was still under consideration. The donations and subscriptions promised to the laboratory, in most cases for five years, had increased and now reached about £2,000. Work had been begun on the new magnetic observatory at Eskdale Muir, for which a sum of £3,000 was provided in the Treasury estimates for the year. Other matters dealt with in the report were publications, the government publication grant of £1,000, and the library. The report also contained the Royal Society's statement on scientific education in schools, made last January, which was forwarded to all the universities in the United Kingdom, and to which many sympathetic replies had been received.

SCIENTIFIC NOTES AND NEWS.

Professor James F. Kemp, head of the Department of Geology of Columbia University, has been elected president of the New York Academy of Sciences.

Professor C. P. Neill, who holds the chair of political economy in the Catholic University of America, has been appointed U. S. commissioner of labor to succeed the Hon. Carroll D. Wright, who will hereafter devote his whole time to the presidency of Clark College. Dr. Wright was given a farewell banquet by the Unitarian Club, at Washington, on the evening of December 14.

Professor Willet M. Hays, who holds the chair of agriculture in the University of Minnesota, has been appointed assistant secretary of agriculture.

At the twelfth annual meeting of the Geological Society of Washington, after listening to a paper by Mr. G. K. Gilbert on 'Crescentic gouges on glaciated surfaces,' the following officers were elected for the ensuing year:

President—G. P. Merrill.

Vice-presidents—Waldemar Lindgren, A. H. Brooks.

Secretaries—G. O. Smith, H. Foster Bain.

Treasurer—M. L. Fuller.

Members of the Council—T. W. Vaughan, David White, F. L. Ransome, M. R. Campbell, T. W. Stanton.

Mr. G. K. Gilbert was selected to represent the society as vice-president of the Washington Academy of Sciences.

MR. LUTHER BURBANK, the well-known California expert on plant-breeding, has been appointed a special lecturer at Stanford University. It is reported in the daily papers that Mr. Burbank has received a liberal grant from the Carnegie Institution, which will permit him to devote himself to scientific work for the next ten years.

As already announced, the council of the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee prize for 1900–1904 to Sir James Dewar. In addition, the council has awarded the Keith prize for 1901–1903 to Sir William Turner for his memoir entitled 'A Contribution to the Craniology of the People of Scotland' and for his 'Contributions to the Craniology of the People of the Empire of India,' Parts I., II.; the Makdougall-Brisbane prize for 1902–1904 to Mr. John Dougall, M.A., for his paper on 'An Analytical Theory of the Equilibrium of an Isotropic Elastic Plate'; and the Neill prize for 1901–1904 to Professor J. Graham Kerr, M.A., for his researches on *Lepidosiren paradoxa*.

THE Astley Cooper prize of £300, which is offered triennially for medical research on a specified subject, has been awarded to Mr. W. Sampson Handley, Hunterian professor in the Royal College of Surgeons, for an essay entitled 'Epigastric Invasion of the Abdomen in Breast Cancer.'

ASSISTANT PROFESSOR CARL KINSLEY, of the department of physics of the University of Chicago, will go abroad on the first of January to spend six months in study at the laboratory of Professor J. J. Thomson in Cambridge.

MR. CHAS. T. KIRK, a graduate student in geology at the University of Oklahoma, is conducting some investigations on the subject of concretions. He desires to correspond or to exchange specimens with any one interested in this particular subject.

PROFESSOR HELY-SHAW, who has held the chair of engineering for the past twenty years at Liverpool, has accepted the post of principal organizer under the Transvaal Technical Council.

THE death is announced of Miss Achsah M. Ely, since 1887 professor of mathematics at Vassar College.

WE regret also to record the death of Dr. Karl Ueberhorst, professor of philosophy at the University of Innsbrück.

SEVERAL specimens of native gold, some of especial value on account of their crystalline form, have disappeared from the mineral cabinet of one of the leading educational institutions. Collectors and curators of museums are respectfully asked to report to Pinkerton's Detective Agency any information that may lead to the identification of the thief or to the discovery of the whereabouts of the specimens.

IT is said that Mr. Andrew Carnegie has given $540,000 for the establishment in Boston of an institute similar to Cooper Institute, which is to be added to a fund of $270,000, which has grown from $5,000 left one hundred years ago by Benjamin Franklin.

THE constitutional amendment exempting the California Academy of Sciences from further taxation was carried at the election November 8, 1904, by a majority of nearly 11,000.

THE seventh biennial convention of the Society of the Sigma Xi will be held on Thursday evening, December 29, 1904, at eight o'clock in the auditorium of Houston Hall, University of Pennsylvania, Philadelphia.

A WESTERN meeting of the American Physical Society is to be held in the Ryerson Physical Laboratory on April 22, 1905. The arrangement of the program is in the hands of Professor Robert A. Millikan, of the department of physics of the University of Chicago.

THE Pelé Club will hold its third annual session at Philadelphia, on the evening of December 28. The organization hopes to be of service to the science of geography in collecting and studying phenomena.

WE learn from the *British Medical Journal* that a meeting of medical men was held in Paris on November 25, when it was resolved to invite British physicians and surgeons to pay a return visit to Paris. Professor Bouchard, member of the Institut, was elected president of the Paris committee, and the opinion

was expressed that some date early in May—probably between May 7 and 14—would be most convenient.

Negotiations have been completed whereby Purdue University is to receive from the New York, New Haven and Hartford Railroad, through the courtesy of Mr. Samuel Higgins, general manager, the historic locomotive 'Daniel Nason.' A few years ago the university interested itself in securing from railways samples of such classes of locomotives as are now being superseded by machines of more modern construction, its purpose being to preserve as museum exhibits types of design which were in danger of becoming extinct. As a result of this plan, a number of valuable relics are already upon its grounds. From the beginning of this movement, an effort has been made to secure a representative of a type which was common throughout New England thirty years ago, namely, an eight-wheeled engine having cylinders inside the frames connecting with the crank axle. This effort has now been crowned with success. The 'Daniel Nason' is said to have been built in 1858. It was exhibited in Chicago in 1893 and has been held as a relic at Roxbury, Mass. The engine weighs about twenty-five tons, is complete with its tender and will be shipped to the University at Lafayette, Indiana, upon its own wheels. The university is also to become the custodian, in behalf of the same railway, for a stage-coach passenger car which is said to have been placed in service in 1835. It consists of the body of a stage-coach suspended over a simple railway truck by means of thorough-braces. It will seat inside and on its top about twenty persons. The American Locomotive Company has presented to the university the full-sized model locomotive cylinders sectioned to show the piston valve construction, which formed a part of its exhibit at the Louisiana Purchase Exposition, St. Louis.

The lecture arrangements at the Royal Institute, London, include the following: A Christmas course of lectures (experimentally illustrated and adapted to a juvenile auditory) on 'Ancient and Modern Methods of Measuring Time,' by Mr. Henry Cunynghame; Professor L. C. Miall, Fullerian professor of physiology, R. I., six lectures on 'Adaptation and History in the Structure and Life of Animals'; Professor Karl Pearson, three lectures on 'Some Recent Biometric Studies'; Professor W. E. Dalby, two lectures on 'Engineering'; Mr. A. H. Savage Landor, two lectures on 'Exploration in the Philippines'; Professor W. Schlich, two lectures on 'Forestry in the British Empire'; Mr. J. J. H. Teall, two lectures on 'Recent Work of the Geological Survey'; Professor H. H. Turner, three lectures on 'Recent Astronomical Progress'; Professor R. Meldola, two lectures on 'Synthetic Chemistry'; Professor J. J. Thomson, three lectures on 'Electrical Properties of Radioactive Substances'; and Lord Rayleigh, three lectures on 'Some Controverted Questions of Optics.' The Friday evening meetings will begin on January 20, when a discourse will be delivered by Professor Sir James Dewar on 'New Low Temperature Phenomena'; succeeding discourses will probably be given by Dr. E. A. Wilson, Mr. Cecil Smith, Mr. J. W. Gordon, Professor H. Marshall Ward, Chevalier G. Marconi, Professor J. J. Thomson, Sir Squire Bancroft, Professor G. H. Bryan, Professor J. Wright, Professor T. Clifford Allbutt, Lord Rayleigh and others.

UNIVERSITY AND EDUCATIONAL NEWS.

The regents of the University of Nebraska have passed a resolution accepting a gift of $66,000 from Mr. John D. Rockefeller for the erection of a building to be used for religious purposes.

Dr. Fowler, late president of Corpus College, Oxford, has under his will left £1,500 to his own college, a like sum to Lincoln, of which he was formerly fellow and tutor and honorary fellow at the time of his death, and £1,000 to Merton, where he was a post-master.

Mr. Clifton D. Howe, assistant in the department of botany of the University of Chicago, has received an appointment to an instructorship in botany in the Biltmore Forestry School.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 30, 1904.

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*SCIENCE AND ECONOMICS.**

IN science we find the dynamics of political economy, as well as many other branches of human knowledge and human speculation. That eminent prelate and statesman, James Cardinal Gibbons, at the dedication of McMahon Hall of Philosophy at the Catholic University of America a few years ago, said that many were of the opinion that the Mother Church did not welcome the results of scientific research—that there might be something to be feared relative to theology and religion in such research—but he asserted emphatically that the church welcomed all science and all revelations of science as new revelations of religion. His eminence recognized and appreciated the great changes in thought which had come over the world of intelligence during the last thirty or forty years, and that nothing could be revealed by science that did not reveal the hand of the great first cause; that science was God's instrument in teaching His handiwork to the human race.

The conflicts of science and religion, about which we heard so much a generation ago, have no place now in the thought of those who see in science such handiwork. We no longer look upon the earth as the spasmodic creation of a few days. Genesis becomes grand and beautiful poetry in place of alleged history. We see in it the traditions of primitive man in his attempt to account for creation. We see the eco-

* Address of the retiring president of the American Association for the Advancement of Science, Philadelphia, December 28, 1904.

nomic development and evolution that brought into existence, through the slow steps necessary to produce it, what we recognize as the earth; and we appreciate more and more that this is to the greater glory of the first great cause than that formerly assumed method, the result of a literal reading of Genesis.

Science is no longer a menace to religion. It has, to be sure, overturned dogmas, upset superstitions, and changed the theological thought of the world, but it has left with us the evidence of that divine economy in creation which is so essential in considering the works of the Almighty; and as the result of increased knowledge which science has brought us the human race is happier, and more generally recognizes that all things must grow slowly, steadily, surely to that stage of perfection which must mark the works of the Supreme Architect.

If this has been the result in the realms of theology, so long ruled by dogma and artificial tenets, science must have had some influence in shaping those matters which belong to the every-day life of man, his business relations, and his social environment. For the present hour I am to consider what this influence has been in overturning, modifying, and extending the theories of economists, and see whether political economy owes anything to science, or what science must and can do in reshaping and extending the great laws of the business world.

First, we must consider that peculiar and interesting doctrine known as Malthusianism. The doctrine set forth by Malthus comprehended more than his celebrated theory relative to the encroachments of population upon the food supply. These supplemental doctrines involved what is popularly known as the iron law of wages, the wages fund, and the law of diminishing returns, all of which have by scientific thought and investigation given way in large degree to theories more rational and more in line with the facts.

Concretely, Malthus announced the theory that population increased in a geometrical and food in an arithmetical ratio, but after the announcement he contented himself with a more general proposition that population, unless checked by war, poverty and other calamities, tended to increase faster than sustenance. Malthus was supported by other writers. There is, of course, something in this doctrine relative to the pressure of population upon the food supply which must be admitted as containing some truth, and at the time Malthus wrote it was supposed to contain the truth. The author of the theory, however, did not anticipate and could not foresee the great changes which would come in the way of the cultivation of the land and in other ways to increase the food supply relative to the increase of population.

The time may come, to be sure, when the Malthusian theory will be revived, but it is not in our day, nor will it be in our century, for scientific thought almost completely overturned the theory and has relieved it of its strength in exciting the fears of economists or of philosophers that the world was gradually but surely coming to that position where it could not supply its population with food, and that some method of checking population must be the resort. The broadening of the area of supply through discovery and the taking up of vast tracts of land were the immediate means of depriving the doctrine of its force, but later on intensive agriculture and the discoveries of science succeeded in relegating the theory to the past. It is perfectly evident that science has accomplished more in reducing the theory to the minimum than all other forces combined: for transportation and telegraphy, by which famines are avoided or minimized, by which prices are equalized, by which the

markets of the world are known every day, are the direct result of scientific discovery and of the application of the laws of nature.

Of course, Malthus depended upon the dogma of the older economists, that labor is the basis of all values, a doctrine which constituted the ground-rock on which Marx and his associates builded their socialistic structure. Science is steadily, and rapidly too, ridding the world of this doctrine, for, in connection with the Malthusian theory, it shows that labor, while the origin of values, is not and can not be the sole basis of all values.

In the light of present-day conditions there is little place for either the theory of the pressure of population upon the food supply or the theory that labor is the basis of all values. We are now having a wheat crop of nearly 800,000,000 bushels, a corn crop of nearly 3,000,000,000 bushels, an oat crop of close upon 1,000,000,000 bushels, and other crops in proportion. This is for our own country alone, and it gives us the privilege of feeding the world and of relieving it of the fears of starvation or of the conditions of abject poverty; these are conditions which now affect few and exceptional cases, and not the masses.

Closely allied to the doctrine of the pressure of population upon the food supply is the law of diminishing returns, a law which holds now in all works on political economy. Science has not destroyed the law, but has modified it. It is fundamental and all-embracing, but is usually applied to the agricultural industry, although it extends in its principles to all industries, as that law of physics that increased speed is at the expense of power applies to all mechanical contrivances; and yet the law of diminishing returns, through scientific discovery and investigation, has been so far modified as to invalidate largely its relation to the Malthusian theory of population.

Volumes might be written relating to the influence that machinery has exerted in this respect—machines whose construction results in processes that parallel the work of the human brain and the human hand. Modern science shows that such machinery does not have the effect outlined by Doctor Smith in his story of the pin machine. To these machines we apply steam, compressed air, water, electricity. All the great forces of nature are brought into play, and through the ingenious contrivances of man supply the forces by which the law of diminishing returns is modified. In all directions this influence is observed; in a thousand directions we see the doing away with the rule of thumb and the application of distinct, positive scientific principles. The factory itself is a scientific structure, involving the highest mathematical skill. Through these things and the application of new principles in agriculture science overcomes the influence of the seasons by preserving products, by equalizing prices, and by all the other means by which the world is brought into closer contact, one nation or people with another.

The latest discoveries are, of course, the most effective in modifying the law. A gentleman in one of the eastern states has about seven acres under glass. He raises cucumbers, lettuce and other things for the winter markets. A few years ago he found that all the plants on the northern side of his houses grew slowly, lacking that development attained by the plants on the southern side. He alternated by transplanting. Still he found the plants on the northern side developed slowly and unsatisfactorily. Of course, he attributed this to the lack of sunlight on the northern side. When he had about given up the idea of securing any evenness in the growth of his plants the town inaugurated a system of electric lighting, and established along the northern side of his houses several powerful

lamps. He then found that the plants on that side of his houses did as well as those on the southern side, the result being that he introduced electric lights in his houses, so that his plants should have the benefit of such lights during the night. The effect of this was that his cucumbers, for instance, grew more rapidly, with more even development, and with a higher grade of tenderness. He sells about ten thousand cucumbers every winter at twenty cents a piece. This discovery was not new with him, for about that time scientific investigators in Italy and some other parts of Europe were experimenting in the use of electric light to perfect the growth of vegetables.

Afterwards my friend made another discovery, not new to the world but new to him, and that was that by sterilizing the soil he could stimulate the growth of plants to maturity, secure freedom from the growth of weeds and the influence of germs in the soil, and anticipate the market. This he did by putting gangs of steam-pipes in the soil about a foot deep, thus absolutely cooking the soil, killing all poisonous germs and all seeds of weed plants, while insects indigenous to the soil and injurious to the growth of vegetables entirely disappeared. He insists that the soil of any farm, conditions being favorable, can be sterilized in the same way, and at small cost, thus rewarding the farmer by relieving him of much labor now necessary in the cultivation of all kinds of plants and vegetables. Such experimentation must, of course, modify the law of diminishing returns to such a degree as, for a while at least, to rob it of its peculiar influence in increasing cost or retarding the supply from the cultivation of certain kinds of land; but, as I have said, the law remains as a law.

In mechanical productions science has also done much towards modifying the theory, although, of course, there is a limit to the power of machinery and to the employment of people that will always preserve the principle involved in the law; but in these directions—in the Malthusian theory of the pressure of population and its accompanying theory of the law of diminishing returns—science has done much to modify the tenets of the older economists.

The next matter in close relation to the Malthusian theory, and one which has yielded largely to scientific research and the application of scientific principles, is the iron law of wages—that law which provided that the working man should and could receive only that amount of wage which was essential to life merely, just enough to keep body and soul together and to keep the human machine properly lubricated for its daily work. This law was fortified and reinforced by the wage-fund theory. Overcoming the one meant the modification or the complete abrogation of the other. The wage-fund theory did not originate with Malthus. It was suggested by Adam Smith himself, and was developed by his followers; but by the power of modern scientific analysis it is given up to-day, so far as its original form is concerned, by all economists, although many of them assert with some reason that it contains valuable truth, and, when properly stated, the whole truth.

As originally stated, the law is that wages, like everything else, are governed by supply and demand, and in the aggregate depend upon the proportion of laborers to the capital available for employing labor, this capital being denominated a wage fund. Doctor Smith said, in his 'Wealth of Nations,' that the demand for those who live by wages, it is evident, can not increase but in proportion to the increase of the funds which are destined for the payment of wages. Malthus and Ricardo held to this doctrine, but argued that wages could not rise, even by increasing

the wage fund, because if the wage-fund were increased and wages were temporarily raised, population, according to Malthus, always pressing on the limits of subsistence, would be enabled to expand, and the increase in the number of laborers would increase the supply relatively to the wage fund, and therefore lower wages. Ricardo held substantially this doctrine, as also did Senior, James Mill, John Stuart Mill, and most of the older writers of the classical school, though on this subject, as on others, John Stuart Mill later somewhat modified his views, and was, perhaps, often inconsistent.

As a result of more scientific consideration, this theory was practically abrogated, and a new one arose, which, in brief, is the theory that production furnishes the true measure of wages. Curiously enough, this theory was first clearly advocated in our own country, and by the late President Francis A. Walker, when he argued that the wage-fund theory and its socialistic corollary were wholly false; that wages depended upon the productivity of labor and not upon capital. He says, in his work on the 'Wages Question,' that the popular theory of wages is based upon the assumption that wages are paid out of capital, the saved results of the industry of the past. Hence, it is argued that capital must furnish the measure of wages. Walker held, on the contrary, that wages are, in a philosophical view of the subject, paid out of the product of present industry, and hence that production furnishes the true measure of wages, the employer purchasing labor with a view to the product of labor, and the kind and amount of that product determining what wages he can afford to pay.

This view has been very widely accepted, both here and abroad, Mr. Atkinson accepting and urging that the only way to raise wages is to raise the product; and applying his power of analysis, he says that in treating this question it must constantly be kept in mind that money is but the instrument of exchange, that real wages are what the money will buy, and that there can not be more real wages than the whole product less the share of capital. If then, we can even approximate the value of the product and divide by the known number of persons employed, we then approximate the annual measure or average rate of wages in terms of money. In other words, to state it briefly, he says that capital must be paid first in order to induce it to contribute, but it is paid only just what is necessary in the market to obtain it, and the rest of the product goes to wages.

The formula of Adam Smith, indorsed and advocated by his followers, is now revised, and should read, instead of as quoted, as follows: "The demand for those who live by wages, it is evident, can not increase but in proportion to the increase of product which is destined for the payment of wages." There have been many laws promulgated relating to wages, but I think that the scientific attitude of the present-day economists rests upon this theory; and it must stand until science restates it, and restates it in such a way that all or the majority of all economists will accept the formula. Certainly we must claim, and truthfully, that science has either abrogated or very largely modified the old theories relating to wages.

Another line of inquiry suggested by my topic relates to the ever-present, irritating and much-controverted questions in regard to a tariff on imports. As yet science has done but little in this respect, but I conceive that it may and will do much in modifying the extreme views on either side that are held by economists, politicians and statesmen. It may be granted that tariff legislation relates entirely to the question of expediency; that there is little, if any, principle involved in the doctrines of either

free trade or protection. That is the present attitude of men, but the power of science is disturbing the older thought and the older doctrines on this great subject, for it is equalizing conditions everywhere, a process which goes on constantly, and which will help to show legislators the true path to be pursued.

In my own view the tariff question is more sociological than economic. Until the conditions of the different peoples that are engaged in competing industries are more thoroughly equalized, probably both the great political parties in our country, acting together, could not get rid of some form of a protective tariff, but when, through scientific methods and the application of scientific principles to industry on a broad scale, the conditions of the people become more thoroughly equalized, I doubt if both parties together will be able to preserve legislation relative to an expediency now felt to be important. A scientific basis of tariff legislation is sure to be advocated, and when it comes it will be the entering wedge to simplifying the commercial and industrial relations of different peoples. As already intimated, the uniformizing of prices, the expansion of transportation, and all the other instrumentalities for reducing the size of the world from an industrial point of view, are affecting and will affect more generally legislation relative to imports and exports.

Scientific economics will lead the economists to depart somewhat from their older methods of treating the business affairs of the world. We have chapter after chapter, repeated in book after book, on the tantalizing question of rent, interest, etc. Science can do but little towards avoiding the waste pages devoted to these subjects; they will remain, but they are chiefly the subject of discussion as to definition. As President Hadley has stated, political economy is very largely a conflict over definitions. This is harmless, but does little if any good. It is gratifying to see that the later works on political economy are making great steps in advance, are treating world-wide questions of present-day interest. They are recognizing the necessity of applying economic principles to the problems which vex us here and now, and that fine-spun theories as to matters having no interest or value as the days go by must give place to advanced treatment of the real, great questions which constitute the elements of industrial society at the present time.

Some of these questions which science will insist upon being treated will include the utilization of waste products. It is only scientific knowledge that can lead to this new development of values. A saved product is one of the necessities of industry at the present time. This utilization has taken place during the last few years, and it has upset some of the old theories as to cost and the returns of capital. By-products of all kinds are usually the source of profit, and in some cases the chief source of profit, to the manufacturer. This enables him to put out his units of original production at a less cost, and with benefit to the community. Nothing is lost which through scientific methods can be preserved. Many, many instances of this will come to the minds of all, but as one superlative illustration I may refer to the by-products of petroleum, which are absolutely, entirely saved through the practical application of scientific processes. It would be difficult to enumerate the products of petroleum saved by the chemical processes of refinement. The Census Office has published a most enlightening bulletin on this very subject of waste products. This utilization of such products interferes with the full force of diminishing returns, modifying the law as progressing conditions demand.

Strange as it may seem, the influence of science upon the chapters relating to finance has been marked and positive. Professor Charles E. Munroe, of George Washington University, has recently pointed out how technical chemistry invades the domains of economics, politics, and diplomacy, and he cites as a striking example of its effects in economics the settlement of the silver question. The far-reaching influence of chemistry in this particular line is easily understood when we consider the relations of the metals, and how these relations have been changed by the application of the principles of chemistry.

A further economic influence is to be found, as Dr. Munroe states, in the reference of a multitude of railroad administrative problems to the chemist, in the steady increase of his force of skilled assistant, and in the fact that his position in the organization has become second to none in importance. This is seen in the use of lamps, beacons, colors, and all the paraphernalia necessary for the conduct of great railway lines.

Economists have not yet adequately dealt with the great projections of modern times in relation to their influence upon economic development and the conditions of the people at large. Science will compel this treatment, and when our able and astute writers take it up we shall find illuminating chapters in the works on the ever attractive department of political economy. The great engineering enterprises, relating not only to transportation, but to various other channels of industrial activity, must result in such treatment; but in transportation alone engineering science has revolutionized many economic conditions. Standing on the highest point of the Brooklyn bridge there are only three things to be seen—the sky above, the water below, and the vast creations of man filling the field of vision everywhere else. It is the application in every direction of the laws of nature, utilized by the power of science, that presents this scene to the human eye.

The constant effort of science to overcome natural laws as well as to apply them must be recognized. A few years ago, at a meeting in New York, a gentleman was deploring the fact that we did not allow Nature's law to have full play; that we were constantly antagonizing Nature at the expense of the welfare of the human race. Mr. Abram Hewitt answered this pernicious doctrine by saying that if nature had been allowed to take its course grass would still be growing in Broadway.

The sociological results of this conflict are too vast for present treatment; they can only be suggested. Congested cities are being relieved of their congestion, and the great suburban population, the finest in the world, is recruited from the congested districts and from the country. Through sanitary discoveries, and through many other elements which are the direct result of scientific processes, we are reducing the power of disease and delaying the time when one ceases to exist. Rapid transportation and the great lines of transportation are facilitating the accomplishment of these wonderful and desirable results. They are reducing the possibilities of war by increasing its severity; they are making the products of one clime familiar to all climes; they are diffusing intelligence and making all people acquainted. Political economy has a vaster field in massing the facts which pertain to this broad branch of its grand science than it has as yet occupied.

Growing out of this will come a saner and more rational treatment of the power of machinery in its effect upon the employment of the people. The facts already show that in this country particularly the percentage of the whole population em-

ployed in gainful occupations constantly rises. The older economists did not have the facts. They had to draw their conclusions from exceedingly limited observation, but with the data covering the whole people the old views are overturned, and we now recognize, as the result of statistical inquiry, that not only does the percentage of the total number of people employed increase, but that the develoment is along the lines of the most skilled labor and in the higher pursuits of life; that the great body of people constituting the base of the industrial pyramid is constantly being narrowed, and to the benefit of the whole. Scientific inquiry in these directions, added to that concerning the great engineering processes, must lead to but one, and that a scientific, conclusion.

Scientific political economy must deal with the question of alimentation, which is important in all treatment of the labor question, and is one of the most vital subjects to attract present-day thinkers. The physiological chemist is claiming attention, and rightly. He is trying to ascertain just what foods are most important, not only from a physiological point of view but economically, and as relating to the efficiency of labor. Professor Marshall has lately made an appeal for a larger number of sympathetic students who have studied working-class problems in a scientific spirit; under this spirit this question of food and the efficiency of labor as depending upon the quality of food must be one of the problems. What is the amount of nutrients contained in different food materials? The relative expense of different kinds of food? The ratio of relative costs of protein, fats, and carbo-hydrates, as well as the relative proportion of these elements? These facts are being ascertained, and it is necessary to know them and the influence of each upon the muscular as well as the mental capacity and development of the individual.

The economy of food must be treated from two standpoints—the physiological and the pecuniary. These elements can not be separated if we are to understand fully the effects of different foods upon the efficiency of labor and the capacity of labor to sustain itself. These things should form a part of political economy. They are certainly far more valuable than any treatise upon rent or interest. Much has been done, but more must be accomplished. Governments, both State and Federal, as well as municipal, are becoming interested in these subjects, our own Federal Government for some years having carried on investigations relative to nutrition. The Carnegie Institution of Washington has taken up this subject with most friendly interest, and under its direction some of the wisest and most skillful experts of the country are conducting their experiments. The Federal laboratories are auxiliaries to this inquiry, and I feel sure that with the united efforts of governments, of scientific institutions, and of professors in colleges and universities there will be produced a body of facts that will clearly and definitely decide the great question of efficiency of labor, so far as food is concerned.

Going back some years, you will remember that Lord Brassey, when contracting for the labor of men of different nationalities in the construction of railroads, found by actual experience the effect produced by different kinds and qualities of food; that when the food of the Italian laborer was changed from macaroni and other things belonging to his national diet to roast beef and those things which make the British workman so superior, his efficiency was increased *pro tanto*.

It is difficult, through any statistical method or through any method depending entirely upon observation, to treat the labor question in all its elements in a way to secure beneficial results, so far as knowl-

edge is concerned. The statistics of wages have undergone a very decided evolution through the application of scientific methods suggested by economists. It can be learned easily—and has been stated—how many men are required permanently to perform the services of a large number of men employed temporarily. The efficiency of labor relates specifically to this subject. For instance, it was ascertained a few years ago that in a number of establishments producing pig iron 310 different employees were required to carry on the works, but that if the workmen had been employed continuously only 71 would have been necessary; that the average earnings of the 310 individual employees were $169, while the consequent average earnings per employee if the work had been continuous for the 71 men would have been $734 per year. A scientific economic analysis of such conditions would probably show a variance necessary to a true economic conclusion; but political economy has not yet attacked such problems with the same force with which it has dealt with other and less important matters.

The treatment of the labor question must, if there are great results to be secured, be brought under the same scientific methods that are applied in other directions; and there are various other statistical elements which, for the intelligence of all people, both employers and employed, require the application of scientific analysis, for I take it that the relations of employer and employee will not be as fully harmonized as may be desired until such application is made. The employer does not understand fully the conditions of his own work: the employee certainly does not understand the conditions of production. All these conditions are the result of scientific development, and that development, in order to secure the very best results in establishing a rational basis for treatment, must have further elucidation before great results can be expected.

As another instance, the volume of products at different periods, as shown by values, is the prolific source of most pernicious doctrines. Our official statisticians have been wrestling with this subject for many years, and some advance has been made, especially during the last national census. I refer particularly to the duplication of values. We say that the product of the mechanical and manufacturing establishments of the United States is, in round numbers, over $13,000,000,000, but this amount represents the value of raw material and labor, each producer returning the full value of his product, which may become the raw material of other manufacturers all along the line. The deduction of the value of the raw material from the total value of the products, of course, simplifies the problem, but it does not scientifically solve it. Scientific methods must be resorted to, and if the political economists, in connection with their allies, the statisticians, will undertake this problem greater progress will be made. So far hints only are to be found in the books. These hints, of course, are familiar to all statisticians, but the difficulty of securing the true product without exhausting the treasury is one of great complexity.

So in the whole field of sociology, involving crime, charity, benevolence, and all that pertains to the efforts of society to remedy existing evils, we need a new method of treatment. There is such a thing as scientific charity, which is immediately concerned with the economic welfare of the people. The great questions of insurance—how to remedy or provide for the economic insecurity which belongs to the present wage system, the compensation of working men for accidents, and everything of the kind—must be the subject of treatment

by political economists. They will need all the science of the actuary, all the skill of the statistician, and all their own power of analysis.

You may ask what can be done in these respects. The official statistician, who, as I have said, is the ally of the political economists, and who recognizes the scope and the necessity of all that is taught in orthodox political economy, also recognizes the need of the further application of economic analysis in the use of the data he collects. He can not study these questions except from the statistical point of view. His duty is to collect, classify, and publish facts relating to the conditions of the people. Their economic interpretation must be, and largely too, the work of another class.

Professor Simon Newcomb, in a tentative way, has made some suggestions along these lines. These suggestions have been submitted to the Carnegie Institution of Washington, with the hope that that Institution may effectively promote not only research in the exact sciences but the analysis of data that are now in existence. He says that the nineteenth century industriously piled up a vast mass of sociological observations and data, as well as data relating to other branches of science, and that this accumulation is going on without end and at great expense in every civilized country. This proposition we all admit. The problem of working out the best results from these observations, however, is one which is not being effectively grappled with, the consequence being that what has been done toward obtaining results consists largely in piece-meal efforts of individuals, frequently leading to no well-established conclusions. He asserts that another feature of the situation is the gradual extension of the principles of exact science into the sociological field; that it is through this extension, rather than through adding to the already accumulated mass of facts, that progress is most to be hoped for in the future.

He therefore suggests that a body of men be employed, organized into a bureau of exact sciences in general, whose work shall be the development of mathematical methods and their application to the great mass of existing observations. He understands well, of course, the difficulty of securing just the right men who can take up in a sociological way—although his suggestions embody many other branches—the exact scientific analysis and interpretation of facts in existence.

Evidence comes from other sources. Dr. Karl Pearson, of University College, London, in commenting upon Doctor Newcomb's suggestion, states that a man of mediocre ability can observe and collect facts, but that it takes the exceptional man of great logical power and control of method to draw legitimate conclusions from them. He thinks that at least 50 per cent. of the observations made and the data collected are worthless, and that no man, however able, could deduce any result at all from them; that, in the language of engineers, we need to 'scrap' about 50 per cent. of the products of nineteenth-century science; that the scientific journals teem with papers which are of no real value at all recording observations that can not be of service to any one, because they have not been undertaken with a due regard to the safeguards which a man takes who makes observations with a view of testing a theory of his own; that in other cases the collector or observer is hopelessly ignorant of the conditions under which alone accurate work can be done; that such a man piles up observations and data because he sees other men doing it, and because that is supposed to be scientific research.

Professor Pearson feels that sociological observations are of the lowest grade of

value in too many cases; that even where the observers have begun to realize that exact science is creeping into the sociological field they have not understood that a thorough training in the new methods is an essential preliminary for effective work, even for the collection of material; that these observers have rushed to measure or count any living form they could hit on without having planned *ab initio* the conceptions and ideas that their observations were intended to illustrate.

Doctor Pearson is skeptical about the right men or the right man, and he thinks the securing of these men is the chief difficulty in organizing any force for the scientific interpretation of the great mass of data now existing; but he says that when the right man is found he must have been rightly trained; that he is to be occupied in drawing logical conclusions from other persons' observation and data; that therefore he must, in the first place, be an adept in scientific method, a first-class mathematician and statistician and a trained calculator and computator. Such a man will be the man who has the courage to 'scrap,' and to do it relentlessly. Science wants immensely the courageous pruner, but Doctor Pearson feels that such a task is not an enviable one.

Such a work is also indorsed by Lord Rayleigh, of the Royal Institution of Great Britain; and Dr. H. H. Turner, of the University Observatory at Oxford, in sympathizing with Doctor Newcomb's suggestion, does not hesitate to say that no one will be found to doubt the necessity of a far more extended discussion of results; that in the days of Newton, perhaps, observations were scarcer than theories, and it was advisable to set them going, but that now there is no doubt whatever that there is a crying necessity that we should organize the discussion of the masses of accumulated material.

Dr. G. H. Darwin is also in sympathy with such work, while in this country Dr. Fisher, of Yale; Dr. Pickering, of Harvard, and others are agreed that we must utilize the vast collections of data and the results of observation in a more scientific way in order that the conditions of the people in all sociological aspects shall be more clearly defined.

All these suggestions are stimulated by what is known as the new political economy. Personally, I do not particularly like that expression, but I do like the phrase 'social economics,' because while political economy deals with the accumulation, distribution and exchange of wealth —fields perfectly legitimate—and sociology is the science of the relations of individuals and institutions, social economics deals with relations in industrial society; hence it comprehends in a broad sense all that is comprehended by political economy, as well as those other elements of present-day economics which relate to other passions than the passion of wealth. We must agree, however, with Buckle, that 'wealth must accumulate before knowledge can begin,' and its corollary, that 'great ignorance is the fruit of great poverty.' We must also recognize Whewell's utterance, that in all cases the arts are prior to the related science. Art is the parent, not the progeny, of science. The wants of the world have developed science. The old alchemists in their work preceded chemical science. So the empirical investigations and researches to discover remedial agencies have bequeathed to the world great stores of knowledge now systematized.

We must also recognize that during the past one hundred and twenty-five years or so political economy, as a separate branch of philosophy, has sprung into existence. The age has been conducive to its development, for it has been one of material progress. Economics has ruled almost at the

expense of ethics, notwithstanding during the same period the world has been constructing great charitable and educational institutions emphasizing its desire to benefit the human race. These institutions, however, have fallen far short of their true purpose. Much of the charity of the world—unscientific, unreasonable—has resulted in more densely populating penal institutions. The scientific investigations of the present time are remedying this fault, and are showing that economics and such institutions must be considered together.

All the strides civilization has made command our admiration, and its onward steps are marked by numerous and convincing evidences; but such evidences are outside the science of political economy, and are considered by it only as the cost may enter into the distribution of wealth it seeks to create, but not as means for a happier and better condition wherein wealth could be more successfully produced.

Under the spur of this progress political economy has flourished—first, by the patronage and through the admiration of all classes. England did not give it birth, perhaps, but cared for it through its infancy, and gave to the world the more matured growth which we call political economy; but England's writers claim that she owes her industrial position in the past to it. It may be that to a too blind following of later teachings she owes to-day the partial loss of her old industrial supremacy. America, if she desires to occupy the place England is vacating, must take lessons of her mother, and profit by her mistakes and advance her scientific understanding to economic truths and principles.

The old school has been content to teach the laws that regulate the production, distribution and exchange of wealth, and these laws have in large measure, and wholly until more recent years, constituted the science of political economy. It has studiously avoided all other matters, and, in the endeavors of its devotees to constitute it a science, has taken no cognizance of the conditions which, favorable or unfavorable, must attend the participators in the production, distribution and exchange of commodities. It has been content to limit itself to things and their relations to individual and national wealth, more particularly the latter, rather than to include in its sphere of creed the vital relations of men. Even Mr. Mill, perhaps the most brilliant writer of his age, informed us that "political economy is concerned with man solely as a being who desires to possess wealth, and who is capable of judging of the comparative efficacy of means to that end. It makes entire abstraction of every other human passion or motive, except those which may be regarded as perpetually antagonizing principles to the desire of wealth, namely, aversion to labor, and desire of the present enjoyment of costly indulgences. * * * Political economy considers mankind as occupied solely in acquiring and consuming wealth." This statement was made in 1844.

Professor John K. Ingram, in 1879, called this a vicious abstraction, which meets us on the very threshold of political economy, and the strictures of our own Professor Walker upon this saying are too well known to be quoted here.

Mr. Mill's statement represents the tenets of the old school, although the founder of the science, Adam Smith, began his labors in it as a professor of moral philosophy, and taught it as a branch of that philosophy. His followers, in their ambition, for many years strayed far from the doctrines of their great master, and with their departure from him political economy lost the sympathy and even the attention of the wageworkers of English and Amer-

ican communities, the very support it largely needs and should have.

It is most gratifying to know that our modern economists are recognizing the weakness of the old doctrines. They are recognizing the necessity of more scientific treatment, of an analysis of conditions, of an interpretation of facts and observations in considering the great wants of the present day. Political economy, like theology and religion, must change with the thought of the age; it must change as industrial and social conditions change; it must seek to ally itself with all the great sciences in every line of work, and to reach conclusions that shall be of vital importance to the working masses of the world. It is a happy sign, as already intimated, that the newer works on political economy are recognizing these things, and are extending the field of their discussions. Here is the great hope and herein lies the importance of the relation of science to political economy. Science is always ready, when the results of its investigations warrant it, to wipe off the slate of yesterday and turn its face to the light. Political economy has not always done this, but it should be as ready as science has been to follow new revelations and announce new truths.

CARROLL D. WRIGHT.

UNIVERSITY REGISTRATION STATISTICS.

A COMPARISON of the figures in the table with those for 1903 (SCIENCE, N. S., Vol. XVIII., No. 467, December 11, 1903, page 738) will show that the majority of institutions given in the table can still point to an increase in attendance over last year; at the same time, the total increase in enrolment at the combined institutions is not as large as it was last year, and considerably smaller than it was two years ago. It was pointed out in the article of 1903 that the effects of the economic conditions of the country would in the ordinary course of events not be felt keenly until 1904, and the figures seem to indicate that there were sufficient grounds for the assumption. A number of universities, not only in the east, but also in the middle west, show a decrease, which in several institutions is quite marked. The losses in individual schools are sometimes due to an increase of requirements, and the tendency to raise the standard of requirements for entrance and advancement, not only in the professional schools, but also in the academic department, is spreading more and more and is no longer confined to one or two institutions. The press during the past year has commented widely upon the fact that the number of students from the west attending higher institutions of learning in the east seems to be decreasing, but an investigation of the facts of the case will show that while the number of western men attending western institutions is unquestionably increasing all the time, there has been no loss in the percentage of western students enrolled at eastern institutions. At Yale, for example, the discussion has suggested the preparation of a table giving the registration from eight large states of the central west and the northwest, most of which support large universities, the states included being Michigan, Ohio, Indiana, Illinois, Missouri, Iowa, Wisconsin and Minnesota, and the figures show that the number of students from these states has grown from 392 in 1902 to 452 in 1904. At Columbia the percentage of students in the corporation (excluding Barnard College, Teachers College and the College of Pharmacy) from the North Central division has increased from 5.87 per cent. in 1902 to 6.56 per cent. in 1904.

The statistics given on page 914 are with few exceptions approximately as of November 1, 1904, and relate to the registration

at twenty of the leading universities throughout the country. One new institution, the University of Virginia, has been added to the list. It may not be amiss to repeat that the higher institutions of learning here represented are not the twenty largest or the twenty leading universities of the country. It might be advisable to increase the list so as to include the twenty-five or thirty largest American institutions, but it seems scarcely practicable at this time. The figures have in every case been obtained from the proper officials of the universities concerned. The changes in enrolment that take place in the course of the year can not of course be considered here, and they are not important enough to influence the general result. In order that a better idea may be conveyed of the registration at these universities during the fall term, two totals are given for the first time this year, one exclusive of the summer session and another, a grand total, including the enrolment of the summer school. An attempt has been made to secure proper uniformity in the statistics, although it is of course impossible to arrive at an absolutely uniform interpretation.

According to the figures of last year the twenty universities enumerated ranked as follows: Harvard, Columbia, Chicago, Michigan, California, Illinois, Minnesota, Cornell, Wisconsin, Yale, Northwestern, Pennsylvania, Nebraska, Syracuse, Ohio, Indiana, Missouri, Princeton, Leland Stanford and Johns Hopkins. Comparing this with the present order, we shall find that there has been no change in the relative positions of the three largest universities, Harvard, Columbia and Chicago. Michigan is fourth, followed by Minnesota, Cornell, California, Illinois, Pennsylvania, Yale, Wisconsin, Northwestern, Nebraska, Syracuse, Ohio, Missouri, Leland Stanford, Princeton, Indiana, Johns Hopkins and Virginia, in the order named. Illinois passed from the eighth to the sixth position in 1903 on account of the incorporation of the Chicago College of Dental Surgery with the School of Dentistry of the University of Illinois. Later, as the result of a suit brought by a stockholder of the College of Dental Surgery, it was held that the officers of the college had not been duly authorized by the directors of the stockholders to arrange for the consolidation. The contract was consequently declared void, and the figures of last year, which were given in good faith, with no thought that the consolidation contract would be declared void, should be changed from 3,661 to 3,239. Taking this into consideration, Illinois really occupies its old position. Both Minnesota and Cornell have passed California, and Pennsylvania has passed Yale, Wisconsin and Northwestern. Indiana shows a considerable loss and has been preceded by Missouri, Leland Stanford and Princeton, the latter two having changed positions. Cornell and Pennsylvania show the largest gains in the east, while Minnesota and Nebraska have the largest increase in the west. Omitting the summer session, the order would be as follows: Harvard, Columbia, Minnesota, Michigan, Cornell, Illinois, California, Yale, Pennsylvania, Northwestern, Wisconsin, Syracuse, Nebraska, Chicago, Ohio, Missouri, Leland Stanford, Princeton, Indiana, Johns Hopkins and Virginia.

As far as the changes in the enrolment of the different universities are concerned, Harvard shows a falling off from 6,013 in 1903 to 5,392 in 1904. The large increase in 1903 was due almost entirely to the expansion of the summer session from 945 in 1902 to 1,392 in 1903, an increase due chiefly to the meeting of the National Education Association held at Boston in July, 1903. The 1904 summer session naturally showed a decrease (from 1,392 to 1,007), and this partly explains the falling off in

the grand total. The summer session figures are exclusive of 326 Porto Ricans in the special summer session. The enrolment in all the departments of the university has fallen off since the last report, with the exception of law and agriculture. The loss in the college may be due to the increasing number of students who are completing the course in three years instead of four.

At Columbia there would be a decrease in the total enrolment were it not for the fact that the New York College of Pharmacy became incorporated with the university on July 1, 1904. The registration at the College of Pharmacy up to November 1 included 435 students, the addition of which more than offsets the loss in the professional schools of law and medicine. The requirement of a baccalaureate degree for admission to the law school was enforced for the first time last year, and this has naturally resulted in a decrease in attendance, which should reach the minimum in 1905. In the medical school not only were increased admission requirements carried into effect for an additional class, but the tuition fee was increased from $200 to $250 per annum, both causes combining to decrease the enrolment by about a hundred students. The scientific schools likewise show a slight decrease. The tuition fee in these schools was also increased from $200 to $250, but this fact seems to have had no particular influence in preventing students from returning to or entering the institution. This year graduate students in applied science registered for the first time in pure science, and are consequently included under the graduate school figures in 1904, whereas they appeared under scientific schools in 1903. Furthermore, the fact that the tuition fee under the faculty of pure science is only 150 dollars per annum no doubt caused a number of students holding a baccalaureate degree to become candidates for the master's degree in the faculty of pure science, instead of for an engineering degree or a B.S. in chemistry under the faculty of applied science. The increase in the graduate schools is, therefore, due partly to the causes just mentioned. The loss in the registration of college women is explained by the fact that special women music students previously registered at Barnard College, whereas this year they were enrolled in the university department of music. Columbia College (men) shows the largest enrolment in its history, exceeding that of last year by 34, there being 145 students registered in the freshman class, the largest the college has ever had. The New York City high schools are sending more men to the college each year, and college students in increasing numbers are taking advantage of the combined courses, whereby they may receive the baccalaureate degree and the law or a science degree in six years, or the baccalaureate degree and the degree of doctor of medicine in seven years. Teachers College shows a slight gain over last year, and the summer session of 1904 was a little smaller than that of 1903, due, no doubt, to the same fact that caused the loss in the summer session at Harvard.

There has been a slight falling off in the total enrolment at the University of Chicago, the greatest loss occurring in the graduate schools. The law school is growing rapidly, the medical school having remained stationary. It should be remembered in making comparisons that the summer session at Chicago does not bear the same relation to the remaining terms as it does elsewhere.

The increase in attendance at the University of Michigan is not large. The academic departments for both men and women, as well as the faculty of medicine, show a decrease, whereas all the other departments have increased in numbers, the largest gains having been made in the engineering

school, the college of dentistry and the summer session. The total gain is no doubt larger than would appear from a comparison of the 1904 figures with those of 1903, inasmuch as it was impossible last year to secure accurate figures for the number of summer session students who returned for work in the fall and who should have been deducted under 'double registration.'

The total enrolment at the University of Minnesota shows a considerable gain over last year, there being 3,886 students registered in 1904, as against 3,550 in 1903. The enrolment of men in the academic department is identical with that of last year, but there has been a gain of 30 women in the same department. The scientific schools show a gain, which is not as large, however, as the increase in the law school enrolment. The requirements in the medical school have been raised, yet the school shows a slight gain over last year. All of the other departments have also had an increase, which is especially striking in the graduate faculties.

The total attendance at Cornell shows an increase from 3,438 to 3,833, which is much larger than the gain noted during the previous year. The college of arts and science and the college of law are the only departments that show a falling off in attendance. Sibley College (mechanical engineering) shows an increase in its total attendance, but a slight falling off in the first year class, which may be explained by the fact that new entrance requirements went into effect this fall for the first time, both advanced French and advanced German, as well as advanced mathematics, being demanded for admission. The college of agriculture shows the largest increase among the various departments, but most of this increase is in the special students, who are not obliged to satisfy the entrance requirements. The summer session, which showed a loss in 1903, has gained considerably.

The attendance at the University of California has grown from 3,690 to 3,738, a gain which is larger than the one recorded last year. The losses in medicine, the graduate schools, in art, dentistry and pharmacy, are more than made up by the increased registration in the other departments, including the summer session.

The University of Illinois shows a gain over 1903, although the figures given in last year's tabulation are larger than those for 1904; the reason for this has been explained above. All of the departments, with the exception of the professional schools of law, medicine and pharmacy, have had an increase in enrolment, this being most noticeable in the scientific schools. The 42 students mentioned under 'other courses' are enrolled in the school of library science.

As noted above, there has been a considerable increase in the attendance at the University of Pennsylvania, which is due in part to the incorporation of a summer school of the college, in which 137 students were enrolled, and of the night school of accounts and finance, in which 164 students are registered. The freshman classes show an increase everywhere except in the veterinary school. The medical school shows a large increase, the veterinary and dental schools have remained stationary, and the graduate department and the law school show a slight falling off. Architecture, mechanical engineering, civil engineering, mining engineering and the Wharton School of Finance and Commerce have had decided gains. Biological and chemical courses also show an increase, whereas there has been a loss in the academic course.

The Yale figures, as far as the grand total is concerned, have remained practically unchanged, the gain being slight. There is an apparent loss in the number of students

registered in the Sheffield Scientific School, which is, however, due to the fact that this year the undergraduate students only were counted, whereas in 1903 graduate students of the scientific department were included here as well as under the graduate schools. The attendance of undergraduates at the Sheffield School shows an increase of about 50 over that of last year. The academic department shows a gain, whereas the others have remained virtually stationary. The only loss worth mentioning is in the law school, a falling off due to increased tuition fees and greatly increased requirements for admission and advancement.

The University of Wisconsin shows a considerable loss, which is, however, not large enough to eradicate the great gains made in the previous year. The academic department shows a large increase.—The registration at Northwestern University has increased, but the total given is a gross total, it having been impossible to indicate all the duplications. The 115 students mentioned under 'other courses' are enrolled in the department of oratory, and the 50 summer session students are divinity students.—The figures for the University of Nebraska are those for the close of the academic year 1903–1904, the figures for this fall not being obtainable.—At Syracuse University gains are noticeable all along the line, being largest in the college and scientific schools and smallest in the professional schools of law and medicine.—The total attendance at the University of Ohio is a little larger than it was last year, most of the departments having experienced no important change. The number of women in the academic department has been increased by 45, whereas the number of men shows a falling off of 50. Stricter entrance rules went into effect in the college, which were in a measure responsible for this decrease. The greatest loss is found in the college of pharmacy. The chemistry building, the home of this department, was totally destroyed by fire last winter, so that the school was compelled to work at a great disadvantage in temporary quarters this year. Next year the department is to be located in the new chemistry building, now in process of construction, so that the loss over the previous year will probably be only temporary.—The University of Missouri shows a gain in its total attendance, in spite of the large falling off in the summer session. In 1903 summer schools were maintained at three places outside of Columbia, Missouri, the attendance aggregating 639, whereas last summer only one school was opened, that at Columbia, at which 260 students were enrolled. Since 1903 a new department has been established, the teachers college, which is responsible for some of the increase. The 90 students mentioned under 'other courses' belong to the departments of agriculture and forestry and the veterinary department. The largest gains were made in the scientific schools.—Leland Stanford, Jr., which had remained practically stationary the year before, shows an increase in all departments.—At Princeton there has been a slight loss as against last year, but the figures for 1904 are larger than for 1902. The loss in the academic department has not quite been offset by the gain in the scientific schools. A good illustration of the encroachment of the scientific schools upon the academic departments in most universities may be found here, for while there were 758 academic students in 1902, there are only 665 in 1904, whereas the number of scientific students has increased from 494 in 1902 to 628 in 1904. The graduate schools show a decrease, arising chiefly from the fact that fewer students of the Theological Seminary than usual are availing themselves of the opportunity to pursue graduate courses in the university.—There has been a consider-

	California.	Chicago.	Columbia.	Cornell.	Harvard.	Illinois.	Indiana.	Johns Hopkins.	Leland Stanford, Jr.	Michigan.	Minnesota.	Missouri.	Nebraska.	Northwestern.	Ohio State.	Pennsylvania.	Princeton.	Syracuse.	Virginia.	Wisconsin.	Yale.
College Arts, Men	505	604	527	} 672	2005	351	590	186	884	729	470	305	315	} 778	221	} 510	665	} 1068	200	844	1286
College Arts, Women	948	784	363		407	325	389	....	447	624	775	268	633		245		.....		.....	608	.....
Scientific Schools*	789	.....	663	1479	528	909	†	....	†	970	560	529	496		673	604	628	370	155	809	774
Law	91	115	342	224	745	111	125	....	187	830	532	211	183	201	160	305	.....	130	192	182	227
Medicine	106	144	560	391	307	629	20	291	.....	417	283	106	150	550	.....	547	.....	154	144	.....	140
Graduate Schools	194	388	709	193	366	132	.....	194	89	10)	135	68	107	51	39	182	92	61	116	205	325
Agriculture	89	.....	.....	184	22	338	.....	....	.....	.....	750	†	258	.....	105	.....	.....	.....	.....	90	.....
Art	196	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	.....	92	.....	.....	.....	.....	60	.....	.....	36
Dentistry	90	.....	.....	.....	108	153	.....	....	.....	108	141	.....	.....	456	.....	362	.....	.....	.....	.....	.....
Divinity	.....	170	.....	.....	43	.....	.....	....	.....	.....	.....	.....	.....	189	.....	. ....	.....	.....	.....	.....	93
Forestry	.....	.....	.....	.....	.....	.....	.....	....	.....	12	.....	†	.....	.....	20	.....	.....	.....	.....	.....	60
Music	.....	.....	35	.....	.....	96	.....	....	.....	.....	.....	.....	360	310	.....	29	.....	595	.....	220	79
Pharmacy	80	.....	435	.....	.....	147	.....	....	.....	64	65	.....	.....	206	16	.....	.....	.....	.....	29	.....
Teachers College	†	154	627	.....	.....	.....	.....	....	.....	.....	.....	157	.....	.....	.....	155	.....	†	.....	.....	.....
Veterinary	.....	.....	.....	103	.....	.....	.....	....	.....	.....	.....	†	.....	.....	82	82	.....	.....	... .	.....	.....
Other Courses	42	.....	13	135	.....	42	.....	71	.....	.....	.....	90	.....	115	162	164	.....	45	.....	.....	.....
Deduct Double Registration.	.....	(141)	(218)	(17)	(15)	.....	(242)	(2)	(187)	(187)	(40)	(198)	(180)	(50)	....	.....	.....	(64)	(116)	(319)	(25)
Total	3130	2218	4056	3364	4516	3233	882	740	1120	3667	3671	1536	2414	2806	1723	2940	1385	2419	691	2668	2995
Summer Session	913	2237	961	744	1007	239	498	....	18	647	215	260	191	50	106	137	.....	59	.....	395	16
Deduct Double Registration.	(305)	(420)	(184)	(275)	(131)	(103)	(174)	....	(14)	(314)	.....	(92)	(92)	.. ...	(71)	(50)	.....	(26)	.....	(132)	(3)
Grand Total, 1904	3738	4035	4833	3833	5392	3369	1206	740	1424	4000	3886	1704	2513	2856	1758	3027	1385	2452	691	2931	3008
" " **1903**	3690	4146	4557	3438	6013	3239	1614	694	1370	3926	3550	1540	2247	2740	1710	2644	1434	2207	--	3221	2990
" " **1902**	3676	4296	4156	3281	5468	—	1648	669	1378	3764	3505	1408	2289	2875	--	2549	1345	2020	—	2884	2804
Officers	330	184	551	451	534	365	72	156	130	270	197	88	173	346	143	330	114	201	45	243	330

* Includes schools of engineering, chemistry, architecture, mining and mechanic arts.

† Included in college statistics.

able decrease in the attendance at the University of Indiana, which is confined almost entirely to the arts and science departments, the law school and the summer session showing a gain.—At Johns Hopkins University there has been a gain in the academic department, a small gain in medicine, and no change in the enrolment of the graduate schools.

Last year we called attention to the fact that the medical schools showed a decided decrease in the great majority of institutions. A reaction seems to have set in this year, for while the decrease in a number of universities has continued, others show gains, the largest increase being recorded at the University of Pennsylvania. The Medical School of Columbia University has dropped into second place, Illinois now taking the lead. Columbia is followed by Northwestern and Pennsylvania, these four institutions having enrolments of over 500 students. The University of Michigan still has the largest law school, Harvard's being second, Minnesota's third and Columbia's fourth. Quite a number of law schools have suffered a loss in attendance. The scientific schools continue to draw large numbers, and at the majority of institutions are growing very rapidly. Cornell has by far the largest enrolment of scientific students, Michigan coming second, Illinois third and Wisconsin fourth. Harvard continues to have the largest collegiate enrolment. Its summer session was also the largest last year, Columbia being a very close second, with California third and Cornell fourth. Columbia with an enrolment of 709 students in the graduate faculties easily maintains the lead in this department, which it has held for several years. Chicago, its nearest rival in this field, has only a little over half as many graduate students as Columbia, Harvard and Yale follow closely behind Chicago. Northwestern has the largest dental school and also the largest school of divinity. The Columbia School of Pharmacy is more than twice as large as that of its nearest competitor, Northwestern University, and Teachers College of Columbia University also remains in a category by itself as far as the number of students is concerned. Syracuse University has the largest school of music, and Yale the largest school of forestry. The Minnesota School of Agriculture is more than twice as large as that of Illinois, which stands second. Columbia seems to have the largest teaching force, but the Harvard figures do not include the 25 teachers specially engaged to give summer courses in art and sciences and 31 instructors and lecturers in the summer school of physical training.

These figures tell their own story, but of course they tell little about the relative rank of the institutions from the standpoint of efficiency, a question with which this tabulation does not attempt to deal.

RUDOLPH TOMBO, JR.,
Registrar.
COLUMBIA UNIVERSITY.

AMERICAN ORNITHOLOGISTS' UNION.

THE twenty-second congress of the American Ornithologists' Union convened in Cambridge, Mass., Monday evening, November 28. The business meeting was held in Mr. William Brewster's museum, and the public sessions, commencing Tuesday, November 29, and lasting three days, were held in the Nash lecture room of the University Museum.

Mr. Charles B. Cory, of Boston, was re-elected president; C. F. Batchelder, of Cambridge, Mass., and E. W. Nelson, of Washington, D. C., vice-presidents; John H. Sage, of Portland, Conn., secretary; Jonathan Dwight, Jr., of New York City, treasurer; Frank M. Chapman, Ruthven Deane, A. K. Fisher, Thos. S. Roberts, Witmer Stone, William Dutcher and

Charles W. Richmond, members of the council.

The ex-presidents of the union, Drs. J. A. Allen and C. Hart Merriam, and Messrs. William Brewster, D. G. Elliot and Robert Ridgway are *ex-officio* members of the council.

Drs. Allen, Dwight, Merriam and Richmond, and Messrs. Brewster, Ridgway and Stone, were reelected 'Committee on Classification and Nomenclature of North American Birds.'

Three associates were elected to the class known as members, and one hundred and twenty-five new associates were elected—the largest number in any one year since the society was founded.

Interesting papers on the subject of bird migration were presented by Professor Wells W. Cooke and Dr. Louis B. Bishop, and the conclusions reached seemed reasonable.

Mrs. Irene G. Wheelock gave a detailed account of her studies, extending over many years, on the regurgitative feeding of nestlings. Her paper created much discussion.

Mr. E. H. Forbush referred to certain disappearing birds, the purple martin, plover, etc., and asked that information concerning them be sent to the Massachusetts State Board of Agriculture.

In his paper on the nesting habits of the flamingo, Mr. Chapman exhibited most excellent views from photographs of the birds which he had taken in the Bahamas. He made many new observations there concerning the domestic life of the species.

Mr. William L. Finley's papers on the land birds of Oregon and California and the sea birds of the Oregon coast, illustrated as they were by beautiful lantern slides, showed what exceptional opportunities he had had for studying the avifauna of the Pacific region.

Mr. Henry Oldys spoke of some interesting bird songs, and Mr. Fuertes gave imitations of bird notes and explained the habits of the birds.

A valuable paper on the birds of the sandhill region of Nebraska was presented by Dr. Robert W. Wolcott. His observations covered a section of country but little known from an ornithological standpoint.

Rev. Herbert K. Job showed a large series of lantern slides from photographs of shore birds, herons and water fowl, and explained the ingenious expedients to which he resorted in order to secure good results.

The report of the Committee on Protection of North American Birds, read by its chairman, Mr. William Dutcher, gave evidence that interest in the preservation of wild bird life was not lacking at the present time.

In the absence of Professor C. F. Hodge, of Worcester, Mass., so well known for his successful experiments in rearing ruffed grouse in confinement, Miss Helen A. Ball explained a series of lantern slides showing the development of the grouse from the chick to adult plumage. She stated that the young became very tame—eating from the hand—and that two adult wild birds placed in the enclosure with the others, soon exhibited no fear, and in a short time it was impossibe to distinguish them, either in plumage or habits, from those raised in confinement.

Following is a list of the papers read at the sessions:

Jonathan Dwight, Jr.: 'A Review of the Gulls which have Light-colored Primaries.'

Wells W. Cooke: 'An Untenable Theory of Bird Migration.'

Irene G. Wheelock: 'Regurgitative Feeding of Nestlings.'

Louis B. Bishop: 'The Direction of Flight in the Fall Migration at New Haven.'

Henry Oldys: 'Some Interesting 1904 Bird Songs.'

Louis B. Bishop: 'The Status of *Helminthophila leucobronchialis* and *Helminthophila lawrencei*.'

JONATHAN DWIGHT, JR.: 'Wear in its Relation to Subspecies.'

WM. R. LORD: 'The Psychological Conditions of Bird Study.'

E. H. FORBUSH: 'Some Disappearing Birds and Suggestions for their Protection.'

FRANK M. CHAPMAN: 'Florida Notes.' Illustrated by lantern slides.

WM. L. FINLEY: 'The Land Birds of Oregon and California.' Illustrated by lantern slides.

C. F. HODGE: 'Experiments in Rearing Ruffed Grouse in Confinement.' Illustrated by lantern slides.

HORACE G. SMITH: '*Cyanocitta cristata*, and other Eastern Birds, at Wray, Yuma County, Colorado.'

A. H. CLARK: 'The Birds of the Southern West Indies.'

B. S. BOWDISH: 'Ornithology of a Churchyard.'

FRANK M. CHAPMAN: 'The Nesting Habits of the Flamingo.' Illustrated by lantern slides.

WM. L. FINLEY: 'The Sea-Birds of the Oregon Coast.' Illustrated by lantern slides.

H. W. GLEASON: 'Illustrated Readings from Thoreau's Journals.'

WM. DUTCHER: 'Report of the Chairman of the Committee on the Protection of North American Birds.'

ROBERT H. WOLCOTT: 'Observations on the Birds of the Sand-hill Region of Nebraska.' Illustrated by lantern slides.

HERBERT K. JOB: 'The Season's Experiences with Shore-birds, Herons and Water-fowl.' Illustrated by lantern slides.

The next annual meeting will be held in New York City, in November, 1905.

JOHN H. SAGE,
Secretary.

SCIENTIFIC BOOKS.

The Jurassic Flora. By A. C. SEWARD, F.R.S. Part I., *The Yorkshire Coast,* London, 1900. Part II., *Liassic and Oolitic Floras of England (Excluding the Inferior Oolite Plants of the Yorkshire Coast)*, London, 1904. Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History). Parts III., IV.

The first two parts of this important catalogue were reviewed at considerable length in SCIENCE of June 12, 1896 (N. S., Vol. III., pp. 869–876). These relate to the Wealden flora, and their great value to science was fully set forth. The third part, dealing with the Jurassic flora of Yorkshire, appeared in 1900, and now the fourth part, embracing the remainder of the Jurassic material in the British Museum is out, and these two parts may be conveniently treated in a second review, as were the first two in the previous one.

The Jurassic flora of Yorkshire is one of the oldest and best known fossil floras of the globe. It was to it that Williamson first gave his attention more than seventy years ago. His first contribution to science consisted in 'an excellent drawing and description' of the plant first called *Cyclopteris Beanii*, since referred to *Otozamites*, collected by his father at Gristhorp Bay. He sent the drawing and description to Messrs. Lindley and Hutton, who were then at work on their 'Fossil Flora of Great Britain,' and they were embodied with commendation in the second fascicle of that work (pp. 127–129, pl. xliv.), which bears date 1833. Between thirty and forty species from the Oolite of Yorkshire are published in that work, most of which were contributed by Williamson. Earlier work in this line had been done by Young and Bird (1822, 1828), by Brongniart (1828) on material sent to him, and especially by Phillips (1829). Of course, only a small part of this rich material is in the British Museum, but Mr. Seward visited many other museums where it is deposited and he reviews the literature of the whole subject. Indeed, as is his custom in these catalogues, he goes over the whole ground not only of the Jurassic flora of Yorkshire, but of that of other parts of Britain and, in a comparative way, of other countries, especially the continent of Europe, but also of Asia (Siberia, Persia, China, Japan, India), of North America and of Australia, even mentioning discoveries in Franz Josef Land and in Argentina. This preliminary correlation of the data of the whole world is an important feature of these catalogues and greatly increases their value. This value is still further enhanced by his critical analysis of the species, in which his latest decisions as to their affinities, and what he considers to be their proper designations, are given.

The bulk of the volume is naturally devoted to a detailed treatment of the material in the British Museum, in which the museum number of every specimen is recorded. But the 'catalogue' becomes, at the hands of Mr. Seward, a systematic treatment of the flora, which attains great importance from the adoption of the latest botanical classification. The Jurassic flora is thus found to embrace Bryophyta (Hepaticæ), Pteridophyta (Equisetales, Lycopodiales, Filicales) and Spermatophyta (Cycadales, Ginkgoales, Pinales). The evidence for the alleged existence of algæ (fucoids) is examined and found wanting, such forms being either referred to the genus *Marchantites* of the Hepaticæ, or rejected as probably not organic. Of these the Cycadales predominate even over the ferns, which latter contribute the largest contingent to the Wealden flora, the conifers occupying the third place in both floras, and the lower groups a very subordinate position. The total Jurassic flora counts 55 species, as against 59 from the Wealden, which contains many more conifers. Every important specimen is fully treated and usually figured either in the text or on one of the twelve plates. Proofs of these plates had been received in advance of the text at the time of my visit to Cambridge, in 1900, and Mr. Seward kindly permitted me to examine them and take notes upon them for use in preparing my paper on the Jurassic flora of Buck Mountain, Oregon, which I had recently collected, and later he had the further kindness to send a set of them at my request to Professor Fontaine to aid him in his elaboration of that flora. They were of great assistance, although, as might have been expected, very few species are common to the two floras. The work in which the Oregon Jurassic flora is treated is now in press.

In the second part, which has recently appeared, dealing with the remainder of the Mesozoic floras of Great Britain, the treatment follows the same lines, but there is no extended introductory survey of the corresponding floras of other countries. The classification, however, is here primarily geological, each horizon being treated systematically. Scarcely any Triassic plant-bearing beds exist in Britain, and the only plants of that age seem to consist of a few indistinct and practically indeterminable specimens from the Keuper beds of Bromsgrove and Pendock in Worcestershire and from Rowington in Warwickshire. A few specimens from both these localities occur in the museum, but only one fruit (*Carpolithes*) could be even generically determined.

The Rhetic is included by Mr. Seward in the Jurassic, but it is very limited in Britain and no such rich plant-bearing beds of it occur as those of south Sweden and Franconia. But there is a thin belt of this age extending from the Yorkshire coast to the cliffs of Dorsetshire, and they are also found near Carlisle and in the northeast of Ireland and north of Scotland. Fossil plants have been found at Ashelworth and Brockeridge; in the East Somerset and Bristol coalfields; at Pylle Hill, Totterdown and Bristol; at Strensham, Worcestershire; and at Binton, Warwickshire. Only three species are described from the material in the British Museum. These are all pteridophytes, but a winged seed (*Carpolithes*) and an imperfectly preserved cone (*? Araucarites*) occur, which are probably gymnosperms. The supposed monocotyledon (*Naiadita*) figured by Buckman, proves to be a lycopod, and the dicotyledonous wood described by Sorby, upon which Dr. Asa Gray laid so much stress as proof of the antiquity of the higher plants, is stated to have been purchased of a dealer, the locality (Lias of Keynsham, near Bristol) being only conjectural.

The Liassic flora is much better represented. This formation stretches across England from the mouth of the Tees to the coast of Dorsetshire, with patches in Shropshire, Cumberland and Sutherlandshire, as well as in the west of Scotland and on the Antrim coast in Ireland. Among the important localities for plants of this age are Lyme Regis, Memburg and Polden, in the southern section, and Whitby on the Yorkshire coast. There are also Liassic plant beds in the interior of England. The great majority of the specimens in the British Museum are from Lyme Regis and Whitby, especially the former. The flora

described embraces nine species, including one fern, three cycads and three conifers. The remaining species belongs to a genus he now calls *Ctenopteris* and regards it as of uncertain systematic position, although, in the preceding part ('Jurassic Flora of Yorkshire,' p. 237) he referred Saporta's *Ctenopteris* to *Ptilozamites* of Nathorst and treated it as belonging to the Cycadales of doubtful affinity. In this I have followed him for the Jurassic plant *P. Leckenbyi*, which is common to the Yorkshire flora and that of Oregon. As Saporta's name has priority it should stand, provided it is really the same genus as the Ptilozamites of Nathorst.

Both fronds and trunks of recognized cycadean plants occur in the Lias of Britain, and Mr. Seward puts both these into what he calls a class, the *Cycadophyta*. This term he attributes to Nathorst, but the latter did not use it in Latin form. I was, perhaps, the first to call attention to the inconsistency of applying the term Cycadales to the foliage of such plants and the term Bennettitales to their trunks, when both kinds are found at practically the same horizon and often in the same beds, with every probability that the leaves were borne on the trunks, but no means of determining which leaves belonged to which trunks.* The dilemma is one existing in the nature of things and can only be escaped through further discovery. We certainly do not escape it by multiplying classes. But as the Cycadales and Bennettitales are already recognized classes, a group that embraces them both can not be a class. It may be called a superclass. Mr. Seward's name has the form given to much higher groups, such as the Pteridophyta and Spermatophyta. It is included under the latter, and, therefore, should have a different termination. The reasons for such a group given by Nathorst and Seward are not sound, and the group name seems useless.

Much the largest number of species are from the Oolite, viz., 42, as against 12 from the Lias, and 5 from the Rhetic, and as these are all additional to the 65 described in the first part from the Oolite of Yorkshire, it is evident that this is the great Mesozoic flora of Britain, and that the floras of other Mesozoic beds are comparatively insignificant. But this is largely the case in other parts of the world. The greater number are from the Great Oolite of Oxfordshire (Stonesfield), Wiltshire (Sevenhampton and Eyeford), Gloucestershire (Chedworth) and Northamptonshire (Kingsthorpe and Leckhampton). The Inferior Oolite yielded nine species, the localities being in Gloucestershire, Northamptonshire and Somersetshire. Five species are from the Oxfordian, which is represented in Wiltshire (Christian Malford), Cambridgeshire (Chippenham) and Northamptonshire (Peterborough), as well as at Scarborough in Yorkshire. Mr. Seward includes the Corallian and Kimeridgian in the Oolite. The former is represented at Malton in Yorkshire, and has yielded three species, the latter at Weymouth and Sandsfoot in Dorsetshire, and contributes two species.

The Jurassic flora described in Part II. contains 18 conifers, 15 cycads, 2 Ginkgoales, 11 ferns, 1 lycopod, 2 Equisetales and 4 thallophytes. Besides these there are described and figured two leaves from Stonesfield which seem to be dicotyledonous. As we can not question the fidelity of the figures, and as these, so far as the material shows, have every appearance of dicotyledonous plants, the doubts must be as to the source of the specimens, but Mr. Seward says that the records clearly state that one of the specimens at least is from Stonesfield, and that 'the rock appears to be identical with that in which the majority of the Stonesfield plants are found.' He inclines to think that the record is reliable, and that we actually have 'a dicotyledon from rocks of the Great Oolite Series.' This seems incredible *a priori*, as thus far no dicotyledonous plant has been discovered lower than the Lower Cretaceous (Older Potomac) of Virginia. The figures recall those of *Populus primæva* of Heer from the Kome beds of Greenland (Urgonian), which was long the earliest dicotyledonous plant known. They differ, however, considerably from that type, and as the lowest veins are not shown, there

* Nineteenth Ann. Rep. U. S. Geol. Surv., 1897–98, Washington, 1899, p. 665.

can be no certainty whether these leaves belong to the genus *Populus*. Mr. Seward is content to place them in the general group Phyllites. It is greatly to be hoped that the Stonesfield beds may be more thoroughly searched for further material of this class.

LESTER F. WARD.

Geology of the City of New York, with a geological map. By L. P. GRATACAP, A.M., of the American Museum of Natural History. Second edition. 1904. Privately issued. Royal 8vo. Pp. 119; 35 figs., 3 plates.

Interest in nature-study has become of great and increasing importance in our general system of secondary schools. Both teachers and pupils are being led to observe more clearly the world about them, and are coming to know the plants, animals and rocks. In a great center of population like New York city the teachers and pupils make up a well-nigh countless multitude, and as regards the local geology the call for a book of instruction and reference is very urgent, as is the need for good but elementary lectures. The latter need, the authorities of the American Museum of Natural History with their rich equipment in specimens, lantern slides and charts, have met; and the former need, the author of the work before us has satisfied in a very interesting and attractive way. Congratulations are due him that the book has reached a second edition.

The work opens with a brief geographical outline and takes up next the topographical features of the four constituent boroughs. The original outlines of Manhattan Island have of course suffered great modification and a very interesting and detailed record of these is given. The matter is timely, because the tendency to remove and forget the ancient landmark, is all too great in American cities and an interest in early local history and a fondness for one's home and dwelling place are all too slightly developed.

A discussion of the rock formations follows with some very good pictures illustrating their mode of occurrence and structural features. The author is almost ultra-conscientious in his endeavor to give due credit to the several writers who are cited. The topic of the waterways receives attention, as does that of the bibliography and of the minerals. Following these the other boroughs than Manhattan are passed in review and a discussion of the glacial geology closes the work.

Mr. Gratacap still adheres to the Archæan age of the metamorphic rocks of Manhattan Island (p. 45) as against the Palæozoic determinations more especially of Professor J. D. Dana and Dr. F. J. H. Merrill, and as the latter's views have been fully set forth it would be of interest to hear the other side defended at length.

Mr. Gratacap ought to have included in the preparation of his work a table of contents and an index. It is a great handicap to the usefulness of a book of 119 pages, with many figures and a map, to lack these essentials.

J. F. KEMP.

Materialen der Stereochemie, in Form von Jahresberichten. Edited by C. A. BISCHOFF. Vols. I. and II., pp. cxxvi + 1978. Braunschweig, F. Vieweg und Sohn.

This comprehensive work consisting of two large volumes aggregating over two thousand pages, is a continuation of the well-known work on the same subject, published in 1894 by the same author in company with Professor P. Walden. This collaborator has also assisted occasionally in the new compilation, but the great bulk of the work has been done by Professor Bischoff. The matter is developed year by year, each yearly section being divided into four subdivisions, namely:

I., General Stereochemistry; II., Optical Isomerism; III., Geometric Isomerism of Optically Inactive Bodies; IV., Relations Between Space-distribution and Chemical Reactions.

Obviously the form of arrangement demands elaborate indexing; hence the editor has prefaced his work by a table of contents of 126 pages, and given it an index of 99 pages as epilogue. Even as it is, the table of contents almost needs an especial index of its own.

The work is characterized by the qualities which are already familiar in the earlier work.

It is unusually complete and thorough in bibliographic detail. No one interested in the development of stereochemistry can afford to be unfamiliar with it, and to all scientific men it must be of interest as an evidence of the extraordinary fruitfulness during the last ten years of an imaginative hypothesis.

T. W. R.

SCIENTIFIC JOURNALS AND ARTICLES.

THE last number of the *Journal of Infectious Diseases* contains the following articles:

WARD J. MACNEAL: 'The Life History of *Trypanosoma Lewisi* and *Trypanosoma Brucei*.' (With Plates XI–XVII.)

FREDERICK A. BALDWIN: 'Pathological Anatomy of Experimental Nagana.'

WILDER TILISTON: 'The Blood in Measles.'

H. T. RICKETTS: 'The Reduction of Methylene Blue by Nervous Tissue.'

WILLIAM DODGE FROST: 'The Antagonism Exhibited by Certain Saprophytic Bacteria against the *Bacillus Typhosus* Gaffky.' (With Plate XVIII., Figs. 1, 2.)

E. O. JORDAN, H. L. RUSSELL, F. R. ZEIT: 'The Longevity of the Typhoid Bacillus in Water.'

ALICE HAMILTON: 'The Question of Virulence among the So-called Pseudodiphtheria Bacilli.'

RUFUS I. COLE: 'Experimental Streptococcus Arthritis in Relation to the Etiology of Acute Articular Rheumatism.'

THE contents of *The American Journal of Anatomy* for December, containing 13 plates and 66 text figures, are as follows: Mall, 'On the Development of the Blood-vessels of the Brain in the Human Embryo'; Dwight, 'The Size of the Articular Surfaces of the Long Bones as Characteristic of Sex; an Anthropological Study'; McMurrich, 'The Phylogeny of the Crural Flexors'; Flint, 'The Framework of the Glandula Parathyroidea'; Streeter, 'The Development of the Cranial and Spinal Nerves in the Occipital Region of the Human Embryo'; Price, 'A Further Study of the Development of the Excretory Organs in *Bdellostoma Stouti*.'

BEGINNING with the number for January 1905, Professor Richard Elwood Dodge of the Teachers College, Columbia University, New York City, assumes full responsibility for the editing and publishing of the *Journal of Geography*. The *Journal* will continue in its present form and character and will deal with geographic education in elementary, secondary and normal schools. All communications should be addressed to the editor at the address given above.

SOCIETIES AND ACADEMIES.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE 153d regular meeting was called to order by the president at 8:10 o'clock, Thursday evening, December 8, 1904. There were forty persons in attendance. The program for the evening consisted of the following three papers:

'Some American Contributions to Technical Chemistry.' Dr. Marcus Benjamin. In this paper Doctor Benjamin presented a summary of the principal advances made in chemistry applied to the arts in this country from the coming of Priestley in 1774 to the present time, beginning with the description of Count Rumford's work and including the oxyhydrogen blow-pipe by Robert Hare, the vulcanization of sulphur by Charles Goodyear, the processes invented by Castner as well as many others.

This paper has adequate footnotes, giving references to biographical sketches of those who had died, and exact reference to papers discussing the invention while the inventor was still living.

The second paper, entitled 'Association of Boron and Nitrogen in Nature,' was presented by Professor F. W. Clarke. Numerous instances were cited to show that wherever boron occurs in volcanic water, compounds of ammonium are also found. The most plausible hypothesis to account for this occurrence is that of Warington, which is based upon the assumption that boron nitrite (BN) exists at great depths in the earth and is acted upon by volcanic waters. In southern California and in Chili the borates occur associated with sodium nitrate, and it was suggested that these deposits, which are lake deposits, may have derived their boron and nitrogen from hot springs which are common in those regions. The borates at Stassfurt are undoubt-

edly derived from sea water and are not associated with nitrogen.

The last paper was presented by Dr. Allerton S. Cushman, who discussed the 'Action of Water on Rock Powders,' in the light of investigations which have been carried on in the division of tests of the U. S. Department of Agriculture. It has been found that wet grinding increases the binding power. This effect seems to be accompanied with direct decomposition of certain constituents of the rock magma which results in forming colloidal films on the particles. The word 'pectoid' is suggested to describe this condition. Most rock powders that have been ground wet show an alkaline reaction to indicators, but if the water is filtered out the reaction is not usually shown. The analogy between the reactions that take place when Portland cement, powdered glass and rock powders are acted on by water was pointed out. The paper was illustrated with the lantern. Microscopic slides were shown with polarized light and indicated that the pectoid films could actually be seen on the surfaces of the wet ground particles.

A. Seidell,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

The five hundred and ninety-first regular meeting was held November 26, 1904.

The first paper was by Mr. Edgar Buckingham of the department of agriculture on 'The Aeration of Soils,' describing recent experiments on various kinds of soils to find the rates of diffusion and transpiration through them, and the density and composition of the gas normally in the soil. Among other things it is found that the proportion of CO_2 increases downwards while the oxygen decreases, the nitrogen remaining nearly constant at 79 per cent.

Mr. W. P. White, of the geophysical laboratory, then spoke (by invitation) on 'Methods of Measuring the Intensity and Damping of Hertzian Waves.'

A null method was used, which eliminated the effect of variations in the spark to such an extent that determinations could be made to agree within one fifth per cent. Fine platinum wire bolometers in vacuo were used, which are more sensitive than thermocouples. When the wire is very fine the resistance and sensitiveness are such as to make aperiodic receivers practicable. The problem of getting interference curves in free air seem thus to be solved. This also renders possible a new method of measuring damping, in which one of two interfering wave trains has its intensity varied by a polarizing mirror. Practically exact interference between the overlapping portions of the two trains is thus secured, and by varying the length of the unquenched portion the intensity of the separate oscillations can be measured, one by one. Like all interference work with damped trains, this method requires pure waves.

Both papers led to considerable discussion.

Charles K. Wead,
Secretary.

THE TORREY BOTANICAL CLUB.

The meeting was called to order at the usual hour November 30, at the New York Botanical Garden, Professor L. M. Underwood in the chair, twenty members being present. The following were elected to membership: Miss Mabel Denton, of Paterson, N. J.; C. B. Robinson, of New York, and Dr. G. H. Shull, of Cold Spring Harbor, N. Y.

The first paper on the scientific program was entitled 'Recent Contributions to our Knowledge of Paleozoic Seed Plants,' and was by Edward W. Berry. It consisted of a brief discussion of recent contributions to our knowledge of those Paleozoic pteridophytes which had formed, or approximated, the seed habit, the work of Professors Scott, Oliver, Kidston, Grand, Eury, Zeiller and Renault. Especial attention was given to the work of Scott and Oliver and to what amounted to a demonstration by them of seed bearing in the cycadofilicean genus *Lyginodendron* (*Sphenopteris*).

C. B. Robinson presented 'Remarks on the Flora of Northern Cape Breton.' To the north of the Bras d'Or Lakes the island of Cape Breton consists of hills 800 to 1,500 feet in height, bordered by lowland of no great

width along much of both coasts and in the numerous river valleys. The interior of the island is a plateau with large areas covered by barrens and sphagnum bogs. In passing eastward from New Brunswick to Nova Scotia the flora becomes distinctly poorer, many species dropping out and few new ones appearing. Cape Breton with a smaller area than the rest of the province and forming its northeastern limit shows a further decrease, although a comparatively large number of forms are known from the island that do not occur on the mainland, while others grow more luxuriantly there, even at the extreme north. Among the former may be mentioned *Samolus floribundus* H.B.K., *Peramium Menziesii* (Lindl.) Morong, *Parnassia parviflora* DC. and *Galium kamtschaticum* Steller; among the latter *Cypripedium reginæ* Walt., *Caltha palustris* L., *Anemone canadensis* L., *Blephariglottis blephariglottis* (Willd.) Rydb., *Vagnera stellata* (L.) Morong and *Rubus Chamæmorus* L. The dwarf mistletoe, *Razoumofskya pusilla* (Peck) Kuntze, apparently of wide distribution in northern Nova Scotia, extends at least fifty miles up the west coast of the island. The ferns are also noteworthy. All the common and a majority of the rarer species of the mainland grow at least as well in Cape Breton, together with two additional species, *Dryopteris Felix-mas* (L.) Schott and *Polystichum lonchitis* (L.) Roth., the former widely distributed, but the latter known only from two widely separated localities.

The third paper, by Le Roy Abrams, was on 'Notes on the Flora of Southern California.' After speaking briefly of the topography and general climatic conditions of southern California Mr. Abrams called attention to the extreme variation in the flora and exhibited a series of specimens illustrating the coastal and mountain floras. Among these specimens were three of his recently described new species: *Cheiranthus suffrutescens, Heuchera elegans* and *Godetia Dudleyana.*

Other especially interesting plants exhibited were *Romneya trichocalyx* Eastw., *Quercus Engelmanni* Greene and *Calochortus Catalinæ* Wats.

EDWARD W. BERRY,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE NOMENCLATURE OF PHYSIOGRAPHY.

TO THE EDITOR OF SCIENCE: I regret very much that the technical nomenclature of the comparatively new science of physiographic geology does not suit Dr. Eastman, of Harvard.

It is essential to ultimately possess a descriptive name for every topographic form. This is a difficult task, and one, in which a field worker, like myself, who seldom has the leisure or opportunity to devote to closet study, finds most difficult, but we do the best we can, and some people manage to understand us.

If I am not mistaken, the science of paleontology, which is indebted to Professor Eastman for his editorial and linguistic assistance, has been floundering for over a century in the throes of an obscure and specialized nomenclature which may be as unintelligible to the physical geographer as the verbiage of the latter seems to Professor Eastman.

It is my opinion, founded on some experience, that language is only an instrument for recording ideas, and that so long as the work is accomplished, the kind or character of the tool is irrelevant. No one appreciates more than I the importance of simple English to good literary form; but I think Professor Eastman is wasting words, SCIENCE'S useful space, and myself and most valuable time, in discussing an elementary lack of literary style, weakness inherent in most men except a few rare literary geniuses, whom, so far as I am aware, have not been noted for their acumen in scientific research, or even in scientific statement.

ROBT. T. HILL.

A PECULIAR HABIT OF THE BADGER.

ONLY now, in reviewing the classic work of Dr. Elliot Coues on 'Fur Bearing Animals,'* have I been brought face to face with his statement regarding a peculiar habit of the badger. Otherwise, the information here given would have been made public long ago.

On p. 288 of that volume he quotes Audu-

* U. S. Geol. Surv., Hayden. Misc. Pub., VIII., 1877.

bon and Bachman (1843) with reference to the actions of a badger in captivity, in part as follows:

> We occasionally saw him assume rather an interesting attitude, raising the fore part of his body from the earth, drawing his feet along his sides, sitting up in the manner of the marmot, and turning his head in all directions to make observations.

The author (Dr. Coues) continues:

> The assuming of this attitude may have been a result of confinement, as I have not observed it when I have seen the animal in a state of nature, nor does it appear to have been noticed by others.

While acting as the geologist of Captain Wm. A. Jones's Expedition through the Yellowstone Park, in 1873, I was enabled to make a few desultory notes concerning the wild animals, a list of which was published in the *American Naturalist* in February, 1874. On a little trip back over our trail along Yellowstone River and Pelican Creek, I passed through two or three of our deserted camps. Near one of these, my assistant shot a fine specimen of *Lepus bairdii*, Hayden,* which upon dissection proved to be a male, to my astonishment giving evidence of having recently suckled its young. The discovery of this interesting fact relating to this species had been made, with abundant evidence, by Dr. Merriam in the same region the preceding year, but this had not been made public at the time.†

At dusk, as we were preparing to camp near the lower end of Yellowstone Lake, we started up a badger which ran from us with its peculiar cross-legged, sidling lope until nearly out of range of rifle shot, when it suddenly turned, rose to a sitting posture, stroked its fore legs down along its side, eyeing us in very much the same manner as is customary with the marmot, remaining thus until I had discharged my carbine by a shot which struck the ground far enough in front to ensure his safety. Upon this he retreated some distance, repeating the performance several times as I advanced towards him, but not again remaining within gun-shot distance. This animal did not move off in a direct line, but pursued a tortuous course as it ran, very much as if he were attempting to dodge a pursuer gifted with greater powers of speed. Moreover, the general course lay along an open swale somewhat transverse to our line of approach. His whole demeanor was wary in the extreme, and fully sustained his reputation as a 'badger.'

Theo. B. Comstock.

Los Angeles, Cal.,
October 10, 1904.

* U. S. Geol. Surv. of Wyoming, etc., Hayden 6th Annual Report, 1872.

† In the article mentioned above (*Amer. Nat.*, 1874), I remarked that *Lepus bairdii* had not been met by me. This was because I had not then seen a description and so did not properly identify it at the time.

SPECIAL ARTICLES.

AMPHIBIA VERSUS BATRACHIA.

The question as to the proper systematic name of the class of vertebrates containing the frogs, toads, salamanders, etc., has been discussed in this journal several years ago by competent authorities with the result that the disputants agreed to disagree as they had done before. The conflicting arguments may be briefly stated as follows: *Amphibia* is the proper term, because it is the oldest class term, while on the other side it was contended that *Batrachia* is the only tenable name, since it is the appellation first given to the group having a compass essentially identical with the limits of the class in its modern acceptance. It is true that *Batrachia* was given to the group only as an order, but it was contended—and I believe correctly so—that it is more essential that the selection of names for groups higher than genera should be guided by their contents rather than by their rank. The law of priority, as distinctly specified by the American Ornithologists' Union code of nomenclature does not apply to these higher group names.

Those who accepted the name *Batrachia* did it under the universal impression that the first application of this term dated from Brongniart's use of the French form *Batraciens* in 1800, latinized in 1802 by Macartney into *Batrachia*. The order so designated corre-

sponded in all essentials to the modern class, including, as it did, both the salamanders and the frogs (though excluding the apodal Cæcilians).

I have long suspected, however, that the term was older, but in spite of persistent efforts I was unable to obtain access to a copy of the book I had in mind. Taking advantage, therefore, of my friend and colleague, Gerrit S. Miller's recent visit to Berlin I requested him to give me the results of an examination of the volume in case he should be able to find it in any of the libraries there. This he has kindly done and the result confirms my suspicion.

The book in question is by A. J. G. C. Batsch, and in entitled: 'Versuch einer Anleitung zur Kenntniss und Geschichte der Thiere und Mineralien.' It was published in Jena and consists of two parts, the first bearing the date of 1788 and containing the general introductory matter and the vertebrates, the other dated 1789, embracing the lower animals and the minerals.

According to Mr. Miller's analysis of the class *Amphibia* in the first part, Batsch divides it into four 'families,' viz., I., *Testudines;* II., *Batrachi;* III., *Lacertæ;* and IV., *Serpentes.* From the enumeration of the genera admitted by Batsch it is evident that he accepted without any essential alteration the scheme of classification proposed twenty years earlier by Laurenti in his 'Synopsis Reptilium,' though adding the turtles which Laurenti for some unexplained reason had left out. Thus the genera *Triton* and *Salamandra* are left with the *Lacertæ*, the cæcilians with the *Serpentes,* and the *Batrachi* consist solely of the genera *Pipa, Bufo, Rana* and *Hyla.* Batsch's BATRACHIA of 1788, therefore, is an exact equivalent of Laurenti's order SALIENTIA of 1768 and becomes a synonym pure and simple of the latter. We have thus traced the German usage of the word 'Batrachier' for the tailless order only, which was thought to have originated with Johannes Müller, in 1832, back to its first propounder.

It is then pretty plain that in view of this discovery the term *Batrachia* has become untenable for the whole class.

Under these circumstances there seems to be nothing else to do but to accept AMPHIBIA as the formal Latin name for the class as it is restricted at present. While there are many good reasons why it would be desirable to retain the word for the combined classes embraced in the term herpetology, I recognize that it would be utterly hopeless to attempt the substitution of a later name of approximately the compass of the present class.

LEONHARD STEJNEGER.
U. S. NATIONAL MUSEUM,
December 16, 1904.

AN ADAPTATION OF THE CARD CATALOGUE CABINET FOR THE STORAGE OF MICROSCOPIC SLIDES.

EVERY worker in natural history who has to prepare and handle quantities of microscopic slides is met with the problem of how to store them safely and in such form that they can be readily referred to. In the special field of Coccidæ in which the writer is interested there has accumulated in the collection of the Department of Agriculture at least 20,000 slides relating to, perhaps, a thousand different insects. To these additions are being constantly made and daily consultation with this slide collection is necessary for purposes of comparison and identification of the new material. The systems of slide storage which have been tried have all proved to be more or less cumbersome and not especially easy of reference except by consultation of indexes, and especially not elastic in the sense of allowing for indefinite additions. In other words, the different styles of grooved slide boxes once filled can not be added to, and in a growing collection it becomes necessary to have elaborate rearrangements at frequent intervals if anything like classification is attempted. If the slides be simply added seriatim the necessity arises for an elaborate card index and the consultation of many different slide boxes to get together the material representing one subject. It seemed to the writer that all these difficulties could be avoided by devising some plan similar to the method of the card catalogue of the different library bureaus.

The result of a study of the subject has

led to the devising of a cabinet and means of storing slides which has proved, in actual experience of a year, to be thoroughly satisfactory in every particular. To enable the slide to be stored as one would an index card a special envelope or jacket for the slide was devised. It is made of strong manilla paper and but little larger than the standard slide size (1 x 3 in.). This jacket is given the dimensions of 3¼ x 1¼ in., and was manufactured in quantity at a cost of about two dollars a thousand. The jacket affords an opportunity for sufficient labeling, and enables the slide to be classified in a specially constructed cabinet exactly as one would an index card. The cabinet follows the general plan of the library index case, is of five drawers of three partitions each, and will hold upwards of 2,000 slides. The guide cards are specially cut to correspond with the slide envelope, and have on the lower edge an extended lip perforated for the countersunk retaining rod which runs just below the level of the slides. This holds the guide cards and gives additional security to the slides, which remain readily in place by their own weight. Each cabinet is arranged with a lock which fastens all five drawers and gives security to the material. The drawers have the retaining device so that there is no danger of their being pulled entirely out and their contents spilled. The envelopes, however, give such protection to the slides that they will not break even from falling some distance, and, furthermore, protect them entirely from dust.

This system of storing slides allows for additions to be made indefinitely, just as in the case of the card catalogue, and enables the most minute and accurate subdivisions and classification of material, especially important where so large a number of subjects are being accumulated and studied as is indicated above. The adoption of this system of filing slides has decreased the work of consultation and handling material at least two thirds, and has rendered such consultation and handling so easy that the whole collection is more often consulted and correspondingly much more serviceable than before. These cabinets, while specially made, are inexpensive, and seem to have solved the problem, at least so far as permanent balsam slide mounts are concerned. In the writer's own preparation of material in his special subject the slides are always thoroughly dried over an alcohol flame as soon as they are prepared. In the case of mounts which can not be thus dried this system will not apply, for the slides can not be placed in such cabinet until they have become thoroughly dried. Once thoroughly dried, however, the intense heat of a Washington summer does not result in any softening or attachment to the enclosed jacket. This system of keeping slides has met with the general approval of all who have seen it, and it seems, therefore, desirable to give it this exploitation for the benefit of those working with similar material.

C. L. Marlatt.

U. S. Department of Agriculture,
December 7, 1904.

QUOTATIONS.

CONVOCATION WEEK AT THE UNIVERSITY OF PENNSYLVANIA.

The American Association for the Advancement of Science held its first meeting in Philadelphia in 1848. After an interval of thirty-six years it met for the second time in Philadelphia in 1884, when the attendance was 1,261. This was the largest meeting in the history of the association, but the numbers were increased by 303 members of the British Association, which met that year in Canada. At the Boston meeting of 1880 there were 997 and at the Montreal meeting of 1882 there were 937 members in attendance. These meetings represent a culminating point in the history of the association, and an important epoch in the development of science. Until 1882 there were only two sections of the association, one for the exact sciences and one for the natural sciences. But at about this period specialization and differentiation became imperative. The conditions were in part met by dividing the association into sections, but more adequately by the establishment of special societies. The American Society of Naturalists was organized in 1883, and has since held winter meetings, the membership being confined to professional students

of the natural sciences. The American Chemical Society had been established in 1876; the Geological and Mathematical Societies were organized in 1888. Since that time special societies have been founded for all the leading sciences, and there is a tendency for them to divide into branches for the different sections of the country.

The establishment of these special societies represents an important advance, but its first effect was to weaken the parent association. Professional men of science found the amateur element too prominent in the summer meeting and the time was inconvenient for many of them. In spite of the great increase in the numbers of scientific men in the country, the meetings became smaller and the membership decreased. But this was only a temporary phase. The interests of men of science are not exactly limited by the conventional bounds of a single science. A zoologist, for example, may be interested in anatomy, physiology, pathology, paleontology, geography, botany, psychology, chemistry or some other science. It is also the case that those who attend the annual meetings like to see their friends from other parts of the country who may be working in fields remote from their own. It is advantageous consequently for the special societies to meet in groups at times, even though they may like occasionally to be isolated, and some machinery is necessary to make local arrangement to secure reduced railway fares and the like.

Then while a small group of experts is the ideal condition for the presentation and discussion of special research, there are wider aspects of science and interrelations between the sciences for the adequate consideration of which workers in different departments must come together. There are also conditions of scientific progress, such as educational methods, scientific institutions, publication, government activities, etc., that need criticism and control. Neither trades unions nor corporations meet with universal approval at the present time, but it is obvious that some union among men of science is desirable for the support of their common interests, which in this case are fortunately identical with the interests of society. Lastly a federation of societies and a large gathering of scientific men is an important factor in keeping scientific work in touch with the outside world and in impressing on it the unity and weight of scientific research.

The complicated conditions appear to have been met by the establishment of 'convocation week' at the end of the Christmas holidays. Under the general auspices of the American Association arrangements are made at some large center for the meeting of the association and of the special societies that care to join with it. The special societies have complete control of their place and time of meeting, of their programs and membership; but without interfering with their autonomy the advantages of a great gathering of scientific men are assured. Thus at Philadelphia, beginning the day after Christmas, there will meet the American Association and its ten sections; the American Society of Naturalists, and some twenty special societies, including those devoted to astronomy, physics, chemistry, geology, botany, zoology, paleontology, bacteriology, physiology, anatomy, anthropology, psychology and philosophy.

The societies are fortunate in their place of meeting this year. Philadelphia is centrally situated, at least for the Atlantic seaboard. The city is noted for its scientific societies and institutions. The University of Pennsylvania is one of the great universities which can offer admirable accommodations to all the societies and at the same time much to interest all men of science. Houston Hall, the beautiful club house of the students, will be an admirable center for social intercourse. The magnificent new medical laboratories will not only give excellent places of meeting for the societies devoted to the biological sciences, but a visit to them would repay a trip from Boston or even Chicago. Each group of scientific men will find something to interest them in the advances made by the university during the ten years of Provost Harrison's administration. These include the laboratories of physics and of chemistry, the engineering hall, the observatory, the botanical garden, the vivarium and the museums, to mention only

certain of the developments connected with the natural and exact sciences.—*The Popular Science Monthly.*

COMPULSORY GREEK AT OXFORD AND CAMBRIDGE.

THE discussion of the 'Greek question' by the resident members of Oxford and Cambridge has disclosed so many contradictory views that the average member of Convocation, in despair of definite guidance, may feel inclined to leave things as they are till the experts have made up their minds as to what they want, and why they want it. The limited proposals before 'Congregation' at Oxford were criticized partly because they went too far, partly for not going far enough —the latter, as we gather, being the view of their most formidable opponent, Sir William Anson, as it was of many half-hearted supporters. With all respect, indeed, to the weighty authority of the Cambridge Professor of Greek, Sir Richard Jebb, we can not follow his argument that the adverse vote at Oxford on a smaller proposal made it highly improbable that, whatever Cambridge might do, Oxford would consent to make Greek optional for all candidates for a degree. On the contrary, we are inclined to think that a bolder and more comprehensive proposal would have had a better chance at Oxford than one which raised a great and far-reaching question upon a comparatively small issue; and that Cambridge, if she goes full steam ahead, need not fear being left in the lurch by Oxford, with the result that, as Sir Richard Jebb seemed to fear, the University which retains more Greek will attract the ablest literary talent. The Master of Trinity, Dr. Montague Butler, a classical scholar of the first rank and a teacher of proved experience, regards such gloomy forecasts as baseless, and wholly dissents from Sir Richard Jebb's view that to make Greek optional would be a serious blow to the interests of the highest liberal education in England and throughout the empire. Who, indeed shall decide when such doctors disagree? It is evident, too, from the debates at either university that many who advocate the change do so in the interest of the same liberal education which its opponents think will be imperilled. They foresee danger if the universities continue to stand too fixedly upon the old ways, making no attempt to readjust their requirements to new conditions and to enlarged views of what constitutes a liberal education.—The London *Times.*

NOTES ON ENTOMOLOGY.

PROFESSOR A. P. MORSE has published the first entomological paper under the Carnegie Institution of Washington.* The greater part of the work is occupied by a list of the species taken (ninety in number), with notes on occurrence, habits, variations, etc. Before this systematic list there is some very interesting ethological matter comprising a classification of grasshoppers according to habitat, and an explanation of brachypterism in orthoptera. The classification by habitat is first into geophilous and phytophilous divisions, each divided into campestrian and sylvan groups, and the campestrian into xerophile and hydrophile societies. He finds an explanation of brachypterism in the fact that these species 'dwell in an environment of more or less dense, intricate, interlacing vegetal growth, * * * or in burrows, crevices, etc.' The excellent plates illustrate the habitats of various species.

Dr. R. W. Hoffmann has published a very interesting article on the morphology and physiology of certain parts of springtails.† He has studied particularly the structure and histology of the ventral tube of these tiny creatures; an organ not found elsewhere in insects, and whose function has never been well understood. Some have believed it to be an organ of generation, others considered it a breathing organ, or an organ to take up water, others thought it an organ of secretion, and still others as used to hold the end of the furcula. Many, however, have thought it was

* 'Researches on North American Acridiidæ.' Publ. no. 18, Carnegie Inst. Wash., Oct., 1904, pp. 55, 8 pls., 13 text figures.

† 'Über den Ventraltubus von *Tomocerus plumbeus* L. und seine Beziehungen zu den grossen unteren Kofdrüsen. Ein Beitrag zur Kenntniss der Collembolen.' *Zool. Anz.*, XXVIII., 1904. pp. 87–116.

useful to hold the creature to a surface by suction, and the author after examining the subject very thoroughly comes to the conclusion that the ventral tube is an organ of adhesion.

The one considerable group of American hemiptera, hitherto never catalogued, has at last received attention. Mr. Otto H. Swezey, who had worked on the life-histories of the Fulgoridæ, now presents a catalogue of that family,* listing nearly 180 species, arranged in 56 genera. The place of its publication proves that the public money is sometimes well spent. Three genera lack reference to place of publication; two of these by Westwood are as follows: *Cenchrea, Trans. Linn. Soc. Lond.*, Vol. XIX., p. 15, 1841; *Patara, ibid.*, p. 13. Interest in this family, one of the most attractive of the hemiptera, will doubtless now rapidly increase, and the many new species in collections (mentioned by the author) will receive the attention of the systematist.

The revival of interest in the Termitidæ has induced Mr. G. Jacobson to study the Russian forms.† There is an historical account of the knowledge of Russian termites; a systematic treatment of the species, describing two new species and one new variety of *Hodotermes;* notes on the life-history of the species; an account of the damage done by white ants in Russia; and a brief account of methods of destroying them. In an appendix Mr. J. W. Wassiljew gives some notes on the habits and nests of a species of the Transcaspian region.

There are but few connected accounts of the embryology of insects as a whole, therefore the book by Felix Henneguy will be of great assistance to all interested in this subject.‡ There is a general account of the external structure of insects, followed by chapters on the internal anatomy. The greater part (500 pp.) of the work deals with the embryology of insects, and subjects related thereto. A long bibliography is appended.

Mr. Distant has issued five parts of his promised 'Insecta Transvaaliensia.'* It is a separate publication, in large quarto; each part with two or three plates, several of them colored. He has been assisted in the work by many specialists. The parts so far issued are excellently prepared, and deal with parts of the orthoptera, lepidoptera and coleoptera (Cerambycidæ).

Claude Morley has published one volume of his promised monograph of British Ichneumonidæ.† This part treats of the subfamily Ichneumoninæ, deals with about 310 species belonging to 49 genera. In the main he follows the classification of Thomson. There are synoptic tables to the tribes, genera and species; a glossary is appended, and there are many unnumbered figures.

Fascicle 19 of Wytsman's 'Genera Insectorum' treats of the Vespidæ, or true wasps. It is by Dr. K. W. von Dalla Torre, and occupies 108 pp., with 6 colored plates. As usual there is a synopsis of the genera, and a catalogue of the known species. It is at once evident that this fascicle is one of the best of the series so far issued, and the result of a careful investigation of the species.

The First Report of the Wellcome Research Laboratories at the Gordon Memorial College has been issued by the Department of Education of the Sudan government at Khartoum, and contains 84 pages and many illustrations. There is an account of the habits and habitats of many Sudanese mosquitoes, and the results of the committee's work in locating the breeding places. Mr. Theobald has furnished a systematic article on the mosquitoes of the Sudan and of Abyssinia, illustrated with colored plates, and describing many new species. The same author enumerates other biting insects, and treats of several other injurious species,

* 'A preliminary catalogue of the described species of the family Fulgoridæ of North America, north of Mexico.' Bull. no. 3, Ohio Dept. Agric., Div. of Nursery and Orchard Inspection, Oct., 1904. 48 pp.

† 'Zur Kenntniss der Termiten Russlands.' *Ann. Mus. Zool. Acad. Imp. Sci.*, St. Petersbg., IX., pp. 57–107, 1904.

‡ 'Les Insectes: Morphologie, Reproduction et Embryogenie,' by L. Felix Henneguy, Paris, Masson et Cie, 1904, pp. 804, figs. 622.

* 'Insecta Transvaaliensia. Contributions to a knowledge of the entomology of South Africa,' by W. L. Distant, London, 1901–1904. 4to.

† 'Ichneumonologia Brittanica; the Ichneumons of Great Britain.'—Plymouth [England], 1903, 315 pp.

particularly of the melon bug and the Dura aphis.

NATHAN BANKS.

*INTERNATIONAL COOPERATION IN SOLAR RESEARCH.**

As chairman of the committee on solar research of the National Academy of Sciences, which had issued the call for the conference, Professor George E. Hale called the meeting to order and explained the purpose of the conference. After referring to previous movements to secure cooperation in solar research, he emphasized the importance of encouraging individual initiative, and urged that no less attention be paid to such encouragement than to the accomplishment of large pieces of routine work through cooperative effort.†

The following officers were then elected to serve for this meeting:

President—Professor George E. Hale.
Vice-president—Professor Henri Poincaré.
Recording secretary—Professor C. D. Perrine.

A motion that for this meeting the voting be by societies and that each society be allowed one vote, was adopted.

A motion was made and carried that the chairman of each society's committee should cast the vote for that society.

After some remarks by Professor Hale on cooperation the following motion was made by Professor Turner:

That this meeting is in favor of the organization of a scheme of international cooperation in solar research which shall encourage individual initiative, provide suggestions for definite lines of work, and facilitate the collection of results for publication.

This expression, after remarks by Professors Poincaré, Boltzmann and Hale, was made the sense of the meeting.

Professor Hale stated that in appointing its committee on Solar Research, the National Academy of Sciences had given the committee authority to join the president and foreign secretary of the academy in presenting its plans for cooperation to the International Association of Academies. The opportunity now existed of securing the views of the conference on this subject.

After remarks by various delegates upon the relations of scientific societies among themselves and to the International Association of Academies, the following motion was made by Professor Poincaré:

That a committee to be appointed at this meeting negotiate with the Academy of Sciences of Vienna with the view of obtaining the approval and the patronage of the International Association of Academies.

This motion was seconded by Professor Boltzmann and adopted.

A short discussion then ensued upon the fullness of the representation of interested individuals and societies in the preparation of plans for cooperation in solar research.

Dr. Bauer moved: That the sub-committee on terrestrial magnetism and atmospheric electricity of the international meteorological committee be invited to appoint a committee to cooperate with the solar research committee.

This motion was seconded by Mr. Rotch and adopted.

Professor Turner moved: That the Hungarian Academy of Sciences of Budapest also be invited to appoint a committee to cooperate with the solar research committee.

This motion was seconded by Professor Frost and adopted.

The following general motion was then made by Professor Poincaré and adopted:

That the international committee on solar research, to be appointed, be authorized to invite, at its discretion, societies and individuals which have been omitted, to cooperate.

The subject of the formation of an international committee was then discussed.

Professor Turner moved: That each committee participating be invited to appoint a member to serve on the international committee.

This motion was seconded by Professor Campbell and adopted.

Mr. Rotch, delegate of the sub-committee of the international meteorological committee on the relationship between meteorological

* Minutes of the meeting of delegates to the Conference on Solar Research, held in the Hall of Congresses, St. Louis, September 23, 1904.

† See *Astrophysical Journal*, December, 1904.

and solar phenomena, reported on the recent meeting of the sub-committee at Cambridge. At that meeting the invitation of the National Academy of Sciences to cooperate with the other committees was accepted.

A short discussion followed on a provisional program of observations, at the conclusion of which Professor Turner nominated the following gentlemen as a committee to prepare a provisional program, such committee to have power to add to its number at discretion:

Professor George E. Hale,
Professor Arthur Schuster,
Professor Svante Arrhenius.

Suggestions from M. Deslandres as to observations to be undertaken, and the adoption of certain names of instruments and solar phenomena, were, at the suggestion of Professor Poincaré, referred to the committee on program.

Following a discussion of routine measurements and computation Professor Turner offered, on behalf of the Oxford University Observatory, to undertake a portion of this work.

A motion was therefore made by Mr. Abbot that the international committee enter into negotiations with the Oxford University Observatory with the view of providing for the measurement of plates and the reduction of solar observations.

This motion was seconded by Professor Campbell and adopted.

The suggestion was made by Dr. Bauer that if visual magnetic observations, especially magnetic observations at the eclipse of 1905, could be made at observatories with special instruments provided for the purpose, it was practically certain that the reduction of such observations would be undertaken by the Carnegie Institution.

A memoir on standards of wave-length, prepared by MM. Perot and Fabry on behalf of the Physical Society of France, was presented by Professor Poincaré.*

A motion that standards of wave-length should be determined from terrestrial instead of solar sources was referred for consideration to the international committee.

Professor Crew discussed the question of standards of wave-length, and pointed out the necessity of replacing Rowland's standards by a new system. He also presented a paper on this subject by Professor Kayser and a letter from Professor Michelson.

Mr. Jewell presented in abstract a paper on Rowland's standards.

A motion by Professor Poincaré was then adopted referring these communications to the international committee.

Owing to a lack of time for discussion the subject of total solar eclipses was referred to the international committee upon motion of Professor Campbell.

Oxford and Meudon were suggested as places for the next meeting. The international committee was empowered to decide both the place and time of meeting on motion of Professor Frost, seconded by Professor Poincaré.

Upon motion of Professor Poincaré the thanks of the conference were tendered to Professor Hale for his interest and activity in connection with the conference.

The conference then adjourned.

Following is a list of committees and delegates appointed by various societies. Other societies will appoint committees in the near future:

Royal Society of England.—Huggins, Christie, Lockyer, Schuster, Newall, committee; Turner, delegate.

Royal Astronomical Society.—Turner, and others to be appointed, committee; Turner, delegate.

Astronomical Society of France.—Deslandres, de la Baume Pluvinel, Guillaume, and others not yet named, committee; Poincaré, delegate.

French Physical Society.—Poincaré, Fabry, Perot, Deslandres, and others not yet named, committee; Poincaré, delegate.

German Physical Society. — Ebert, Kayser, Kreusler, Lummer, Pringsheim, Runge, Straubel, Wilsing, committee.

Amsterdam Academy of Sciences.—Kapteyn, Julius, committee; Kapteyn, delegate.

Society of Italian Spectroscopists.—Tacchini, Ricco, Chistoni, Mascari, committee.

* To be published in the December number of the *Astrophysical Journal.*

Vienna Academy of Sciences.—Hann, Weiss, von Lang, Exner, committee; Boltzmann, delegate.

St. Petersburg Academy of Sciences.—Backlund, and others not yet named, committee; Backlund, delegate.

Sub-committee of International Meteorological Committee.—Rotch, delegate.

Stockholm Academy of Sciences.—Arrhenius,* delegate.

Astronomical and Astrophysical Society of America.—Frost, Abbot, Bauer, Jewell, Perrine, committee; Frost, Abbott, Bauer, Jewell, Perrine, delegates.

American Physical Society.—Ames, Crew, Lewis, Mendenhall, E. F. Nichols, committee; Crew, Mendenhall, delegates.

National Academy of Sciences.—Hale, Campbell, Langley, Michelson, Young, committee; Hale, Campbell, delegates.

George E. Hale,
President.
C. D. Perrine,
Recording Secretary.

THE FRANKLIN FUND.

The Boston *Transcript* gives further details in regard to Mr. Andrew Carnegie's gift to the Franklin Fund. It appears that he has offered to duplicate the amount of the fund as it stood last September—$408,396.48. His gift is to be used as an endowment for the Franklin Union or Franklin Institute, whichever name it may finally bear, on the following conditions:

1. That the Franklin Fund be devoted to the establishment of a school for the industrial training of men and women along the lines of the Mechanics' and Tradesmen's School of New York and the Cooper Union.

2. That the city of Boston shall furnish a site.

The information was imparted to the managers of the fund by a letter recently written to Mayor Collins, chairman of the fund, by President Henry S. Pritchett of the Institute of Technology. In the letter Dr. Pritchett said:

"In September last I had some talk with Mr. Andrew Carnegie concerning the history of Franklin's bequest to the city of Boston. Mr. Carnegie took great interest in the outcome of Franklin's effort, both from his admiration of the character of Franklin, and from the desire to see the gift a helpful one. The outcome of this talk was his suggestion that he would furnish an endowment equal in amount to the sum available from Franklin's bequest. Upon my return to Boston, I sent to Mr. Carnegie a copy of Franklin's will, together with a statement of the treasurer of Boston showing that the amount available at that time was $408,396.48. Recently Mr. Carnegie has written me, saying that after looking over these papers, he saw no reason to modify his original suggestion, and formally renewing his offer to duplicate the amount mentioned as an endowment for the Franklin Union or the Franklin Institute, whichever name it may finally bear."

Dr. Pritchett then quotes the conditions Mr. Carnegie imposes, as stated above. In conclusion the letter says, Mr. Carnegie's thought is, perhaps, best shown by the following extract from his letter:

"I am a trustee of both the schools mentioned and do not hesitate to say that to the best of my knowledge no money has produced more valuable results. I think it is from the class who not only spend laborious days, but who also spend laborious nights fitting themselves for hard work, that the most valuable citizens are to come. We are here helping only those who show an intense desire and strong determination to help themselves—the only class worth helping, the only class that it is possible to help to any great extent."

SCIENTIFIC NOTES AND NEWS.

The new series of Science completes with the present issue its tenth year and twentieth volume.

At the time we go to press all indications point to a most successful meeting of the American Association for the Advancement of Science and the affiliated societies at Philadelphia during convocation week. Full reports of the meetings will be published in the next and subsequent issues of this journal.

The Paris Academy of Sciences has bestowed upon Sir James Dewar its Lavoisier gold medal.

* Acting informally.

DR. DONALD MACALISTER, the representative of Cambridge on the General Medical Council for the last fifteen years, has been elected president of the council in succession to Sir William Turner, K.C.B., principal of Edinburgh University.

WE learn from the *British Medical Journal* that the University of Marburg, on the occasion of the four-hundredth anniversary of the birth of Landgrave Philip the Magnanimous of Hesse, conferred the honorary degree of doctor of medicine on Professor Adolf Harnack, of Berlin, the famous historian of theological dogma. The reason of this distinction is that Dr. Harnack contributed an essay on medical matters in the earliest period of church history to the *Festschrift* produced in honor of his father-in-law, Professor Thiersch, the distinguished surgeon of Leipzig.

THE Rev. Francis Bashforth, second wrangler 1843, formerly fellow of the college, and distinguished for his researches in ballistics, has been elected to an honorary fellowship of St. John's College, Cambridge.

DR. K. A. HASSELBACH, docent of physiology in the University of Copenhagen, has been appointed head of the laboratory of the Finsen Institute in that city.

PROFESSOR JOHN A. MILLER, of Indiana University, will be among the American astronomers who will go to Spain next year to observe the total eclipse of the sun on August 13, 1905.

DR. O. HECKER, of the Potsdam Magnetic Observatory, Germany, is now engaged at Tokio, Japan, in gravity and magnetic measurements and in making comparisons with those of Professor A. Tanakadaté, of the Imperial University at Tokio.

MR. L. Y. AYSON, commissioner and chief inspector of fisheries for New Zealand, has arrived in California for the purpose of taking home with him eggs of the white fish and salmon.

DR. FRIEDRICH HOFFMANN, an eminent student of scientific pharmacy, died at his home in Charlottenburg on November 30. Dr. Hoffmann lived in New York City from 1862 to 1895 and was well known for his scientific work and as editor of the Pharmaceutische Rundschau. He was a fellow of the American Association for the Advancement of Science.

PROFESSOR J. L. BUDD, for twenty-two years at the head of the horticultural department at the Iowa State Agricultural College, has died at San Antonio, Texas.

DR. GAETANO COCCHI, who was sent by the Italian government to study malaria in South America, has died of yellow fever at Merida in Mexico.

THE heirs of Professor Virchow have given about $12,000 to be applied towards the prevention of infant mortality in Berlin.

IT is stated in *Nature* that a valuable collection of specimens illustrative of the fauna of the deep sea has recently been received at the British (Natural History) Museum as a gift from the king of Portugal. The collection is reported to include a number of deep-sea fishes, among which are sharks of considerable size.

THE Russian admiralty is perfecting arrangements to send, as soon as the war is over, an expedition headed by Admiral Vilchitsky, chief of the Hydrographic Bureau, to explore thoroughly the Arctic route to the Far East.

THE National Educational Association will meet at Asbury Park and Ocean Grove, N. J., from July 3–7, 1905, under the presidency of Dr. Wm. P. Maxwell, superintendent of schools of New York City.

THE Franklin Institute of Philadelphia announces the following program of popular science lectures, to be given in Association Hall, Fifteenth and Chestnut Streets, under the joint patronage of the institute and the Central Branch of the Y. M. C. A.:

Friday, January 13.—Professor Leslie W. Miller, School of Industrial Art, Philadelphia, 'Civic Beauty and Civic Duty.'

Friday, January 20.—Mr. H. E. Duncan, American Waltham Watch Co., Waltham, Mass., 'The Mechanism of the Pocket Watch.'

Friday, January 27.—Mr. Fred. E. Ives, New York, 'Here and There with a Color Camera.'

Friday, February 3.—Professor Angelo Heilprin, Philadelphia, 'El-Kantara: A Glimpse of the African Desert.'

Friday, February 10.—Dr. B. H. Warren, Commissioner of the Dairy and Food Division of the Department of Agriculture, Harrisburg, Pa., 'The Adulteration of Food Commodities and Pennsylvania's Method of Suppressing the Growing Evil.'

Friday, February 17.—Mr. W. N. Jennings, Philadelphia, 'Snap-Shots in Florida and Cuba.'

The executive board of the association for Maintaining the American Women's Table at the Zoological Station at Naples and for promoting Scientific Research by Women wishes to call attention to the opportunities for research in zoology, botany and physiology provided by the foundation of this table. Each appointee of the association who has occupied the table for at least three consecutive months, may receive the title of Scholar of the Association, if, in the judgment of the executive board, she is entitled to this distinction. The appointments are made by the executive board with the cooperation of a board of advisers, to whom work presented as evidence of research may be submitted. The members of the present board of advisers are Professor Ethan A. Andrews, of Johns Hopkins University, Professor R. H. Chittenden, of Yale University, and Dr. W. T. Porter, of the Harvard Medical School. The year of the association begins in April, and all applications for the year 1905 should be sent to the secretary on or before March 1, 1905. Application blanks and detailed information in regard to the advantages at Naples for research and collection of material will be furnished by the secretary, Mrs. A. D. Mead, 283 Wayland Ave., Providence, R. I.

Nature says: "The sale of Chartley Park, Staffordshire, the hereditary seat of Lord Ferrers, involves also a change of ownership of the remnant of the celebrated herd of white cattle which have been kept there for the last 700 years. It is much to be regretted that the cattle could not have gone with the park, and have been maintained there by the new owner; but as this is not to be, it is to be hoped that they will be given a safe home elsewhere, where they will flourish and increase. It was long considered that the herds of wild cattle in various British parks were direct descendants of the wild aurochs, but it is now generally admitted (largely owing to the writings of Mr. Lydekker) that they are derived from domesticated albino breeds nearly allied to the Pembroke and other black Welsh strains, some of which show a marked tendency to albinism. This view, as pointed out by a writer in the *Times* of November 29, is strongly supported by the fact that the Chartley cattle frequently produce black calves. The theory advocated by a later writer in the same journal that the British park cattle are the descendants of a white sacrificial breed introduced by the Romans rests upon no solid basis. The Chartley cattle, believed to be reduced to nine head, are to be captured by the purchaser—no easy task."

The *British Medical Journal* states that the Liverpool School of Tropical Medicine is about to dispatch an expedition to study yellow fever at the Brazilian town of Manaos, the capital of the Amazonas province of the Republic. It is situated at the point where the Rio Negro enters the river Amazon. Manoas is a great center for the rubber trade. The members of the expedition are Dr. Wolferton Thomas (Canada) and Dr. Anton Brienl (Prague). The same school is sending an expedition, consisting of Professor Boyce, F.R.S., Dr. Evans, and Dr. Clarke, to Sierra Leone and the Gambia, and another, consisting of Colonel Giles, I.M.S., and Dr. MacConnell (Canada), to the Gold Coast, Logas and Nigeria. The members of the several expeditions were introduced by Sir Alfred Jones, the president of the school, to the Colonial Secretary on December 7. Mr. Lyttelton said that no service could be more acceptable and honorable than that directed to making more safe and useful tropical regions to which Englishmen went to do the work of the Empire.

Nature states that the Danish Commission for the Study of the Sea, which is charged with carrying out the Danish portion of the cooperative international investigations, has issued the first memoirs of its report, which is published under the title 'Meddelelser fra Kommissionen for Havundersøgelser." The report, which is to be written in English or German, and is issued in quarto form, uni-

form with the *Bulletin* of the Central Bureau of the International Council, is divided into three series, dealing respectively with fisheries, with hydrography and with plankton. Of the fisheries series one memoir is now published, viz., C. G. Joh. Petersen, on the larval and post-larval stages of the long rough dab and the genus *Pleuronectes* (with two plates); of the hydrographic series three memoirs, Martin Knudsen, on the organization of the Danish hydrographic researches, H. J. Hansen, experimental determination of the relation between the freezing point of sea-water and its specific gravity at 0° C., Niels Bjerrum, on the determination of chlorine in sea-water and examination of the accuracy with which Knudsen's pipette measures a volume of sea-water; and of the plankton series two memoirs, Ove Paulsen, plankton investigations in the waters round Iceland, C. H. Ostenfeld, on two new marine species of Heliozoa occurring in the plankton of the North Sea and the Skager Rak. The memoirs are of interest as being amongst the first fruits of the international scheme of cooperative research. They are, however, all short memoirs, dealing with what may be considered as side issues of the main investigations, the reports upon which must be looked for at a later date. The Danish commission, which is appointed by the Danish Board of Agriculture, consists of Professor C. G. Joh. Petersen (chairman), C. F. Drechsel, C. H. Ostenfeld and Martin Knudsen (secretary).

Nature states that a list of awards to exhibitors from Great Britain and Ireland at the St. Louis International Exhibition has been received from the secretary of the Royal Commission appointed for the exhibition. The number of grand prizes gained by Great Britain is 121, while 238 gold medals, 162 silver medals, and 132 bronze medals have been awarded to British exhibitors, making a total of 653. Among these awards are the following:—Department of Liberal Arts: photography, grand prize, Sir W. de W. Abney, K.C.B., F.R.S.; the Royal Observatory, Greenwich; the Royal Photographic Society; the Solar Physics Observatory; and Sir Benjamin Stone; gold medal, the Geological Photographs Committee of the British Association; the Cretan Exploration Fund; and the Survey of India. Maps and apparatus for geography, grand prize, Board of Agriculture and Fisheries; Ordnance Survey of Great Britain and Ireland; Royal Geographical Society; Admiralty (Hydrographical Department); the Survey of India; Palestine Exploration Fund. Chemical and pharmaceutical arts, grand prize, low temperature research exhibit of the British Royal Commission; Sir William Ramsay, K.C.B., F.R.S.; gold medal, Dr. Ludwig Mond, F.R.S.; the Owens College; Royal College of Science, London. Awards to collaborators, gold medal, Professor James Dewar, F.R.S. (low temperature research exhibit); Mr. T. Wilton and Dr. A. R. Garrick. Various applications of electricity: awards to collaborators, grand prize, Lord Kelvin (for important contributions to electrical engineering); gold medal, Professor Hugh Langbourne Callendar, F.R.S., Mr. W. du Bois Duddell. Theory of agriculture: grand prize, the Rothamsted Experimental Station (Lawes Agricultural Trust); gold medal, Board of Agriculture and Fisheries; Royal Agricultural Society. Department of Horticulture: appliances and methods of pomology, grand prize, Board of Agriculture and Fisheries; Royal Horticultural Society; the British Royal Commission; gold medal, Dr. Henry. Department of Forestry: appliances and processes used in forestry, gold medal, Forest Department, India; silver medal, the Royal Scottish Arboricultural Society. Department of Mines and Metallurgy: ores and minerals, grand prize, Home Office (Mining Department); Department of Agriculture and Technical Instruction for Ireland. Geological maps and plans of mines, grand prize, Geological Survey of India. Mining literature, grand prize, the Iron and Steel Institute; the Geological Survey of India; gold medal, the Institution of Mining Engineers. Fishing equipment and products: grand prize, Marine Biological Association of the United Kingdom, for an exhibit prepared at their Plymouth laboratory illustrating the life-history and the food of fishes, and a gold medal for publications. Department of Anthropology: ethnography, grand

prize, Cretan Exploration Fund; Egypt Exploration Fund; Palestine Exploration Fund.

According to Mr. F. H. Oliphant, in the annual report of the U. S. Geological Survey, the total production of crude petroleum in the United States in 1903 was 100,461,337 barrels, a gain of 11,694,421 barrels, or 13.17 per cent. over the production of 1902. The great increase was mainly due to the remarkable output in California, which is now larger than that of any other state. California produced 24.27 per cent., or nearly one fourth of the entire production. Next to California the largest gain in production was in Indiana, which was 1,705,515 barrels, an amount that represents a gain of 22.80 per cent. over the state's production in 1902. Kansas showed a remarkable gain in production—600,465 barrels, or 181 per cent.; Kentucky and Louisiana showed gains of about 369,000 barrels each; Indian Territory gained 101,811 barrels, or 274.4 per cent.; and New York gained 43,248 barrels, or 3.86 per cent. On the other hand, there was a slight decrease of production, 128,086 barrels, or 0.708 per cent., in Texas; and Ohio, Pennsylvania and West Virginia all showed decreased production, amounting to a total of 1,856,619 barrels, or 3.98 per cent., in 1903 as compared with 1902. The largest decrease in production in 1903 was in Pennsylvania, and amounted to 708,724 barrels. During the last six years there has been a very remarkable change in the percentage of the local production. The Appalachian and the Lima-Indiana fields, which for many years produced all but a very small percentage of the whole, produced in the year 1903 only 55.38 per cent. of the total, whereas in 1898 these fields produced 93.99 per cent. of the total. California and Texas have been the most important factors in bringing about the readjustment of the percentages of production.

University and Educational News.

Mr. W. A. Riebling, of Newark, N. J., has sent an additional $10,000 to the Rensselaer Polytechnic Institute, Troy, N. Y., to be used in replacing the building destroyed by fire. Mr. Riebling gave $10,000 last June. A gift of $5,000 from Mr. George B. Cluett is also announced.

Wellesley College has received $7,200 from the Robert Charles Billings fund, the income of which is to be applied to the department of botany.

Mr. Thomas McLean has bequeathed £5,000 to the University of Birmingham for the Department of Physics.

Nature states that Professor Woodhead has obtained from friends resident in or connected with Huddersfield a sum of more than 1600*l.* for the endowment of a Huddersfield lectureship in special pathology at Cambridge.

The New York *Evening Post* states that it is probable that the work which Dr. William Osler has been doing at Johns Hopkins will be divided when Dr. Osler goes to assume the regius professorship of medicine at Oxford. It has been suggested that Dr. William H. Welch, now Baxley professor of pathology at Johns Hopkins and pathologist to the hospital, be appointed professor of medicine and director of that department, and that Dr. William S. Thayer, who has been closely associated with Dr. Osler, at Johns Hopkins, be appointed professor of clinical medicine, and Dr. Lewellys F. Barker, of Chicago, be appointed professor of experimental medicine.

Mr. W. McKim Marriott, assistant in the department of chemistry, University of North Carolina, has accepted a research assistantship in the chemical department of the Cornell Medical College in New York City.

Professor Arthur Robinson, of King's College, London, has been appointed to the chair of anatomy at the University of Birmingham, in succession to Professor B. C. A. Windle, now president of Queen's College, Cork.

Dr. Gisbert Kapp, lecturer on dynamo construction in the Technical Institute, Charlottenburg, Berlin, has been elected the first professor of electrical engineering at Birmingham.

Mr. F. F. Blackman, of St. John's College, Cambridge, has been appointed reader in botany in the place of Mr. Francis Darwin.